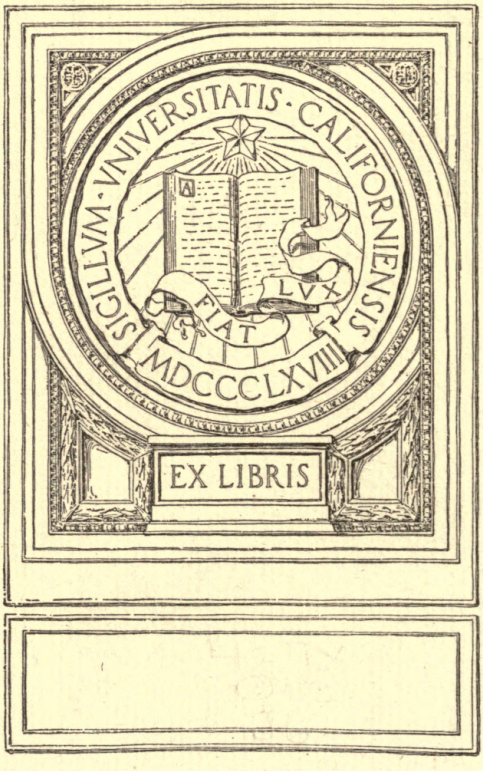
GEOLOGICAL AND ARCHÆOLOGICAL NOTES ON ORANGIA

J. P. JOHNSON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GEOLOGICAL & ARCHÆOLOGICAL NOTES ON ORANGIA.

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AND
ARCHÆOLOGICAL
NOTES ON ORANGIA

BY

J. P. JOHNSON

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WITH ILLUSTRATIONS

LONGMANS, GREEN AND CO.
39 PATERNOSTER ROW, LONDON
NEW YORK, BOMBAY, AND CALCUTTA
1910

PREFACE.

The object of this volume is to co-ordinate the geological and archæological notes accumulated during my many visits to Orangia.

I am indebted to the Commission (consisting of Professor R. B. Young, of Johannesburg, Mr. T. N. Leslie, of Vereeniging, and myself), appointed by the Government to Report on the Desirability and Possibility of preserving the Petroglyphs and Rock-Paintings, for permission to include the copies from Fouriesburg, Ficksburg, Koffyfontein, Biesjesfontein and Baviaanskranz: these, as well as those from the other localities, were made by myself.

The volume constitutes a condensed survey of the geology and archæology of Orangia.

P.O. Box 6231 Johannesburg.

December, 1909.

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GEOLOGICAL AND ARCHÆOLOGICAL NOTES ON ORANGIA.

CHAPTER I.

INTRODUCTION.

GEOGRAPHICALLY, Orangia may be described as the country lying between the Vaal and the Orange rivers. Politically it is more restricted, the plains west of the Capetown-Kimberley-Bulawayo railway and the hills east of the Caledon river belonging to neighbouring States. Both in regard to its physical features and its climatic conditions it represents the exact mean of that portion of South Africa which is at present inhabited by the white man.

The railway from Capetown to Johannesburg *viâ* Bloemfontein almost exactly bisects this territory. The traveller from the coast, after crossing the Orange river, looks out on to a monotonous stretch of gently undulating grass veld dotted here and there with a kopje or randje,* and lit up by a blazing sun. In places, especially in the south, the grass is replaced by tiny shrubs while most of the kopjes and randjes are sparsely dotted with bushes, but neither are visible from a distance. If it is in the dry season, which extends from March to August, the veld will have a brown parched appearance, and the sky overhead will be a clear blue perhaps with flecks of white, but if it is during the wet season the veld *may* be a pleasing green and the sky overcast, for the rains are very intermittent and the heavens are seldom clouded. At long intervals he will pass

* Translated literally, kopje means a little hill, but the adjective rugged must be added to convey a correct picture to the mind. A randje is a little ridge or range of kopjes.

a patch of bush or a tree-encircled homestead, but they are too few and too insignificant a feature in the landscape to afford any relief to the eye. Two objects only will excite his curiosity; the pan—a large oval depression in the ground with a bare flat bottom—of which he will see several examples, and the small hemispherical mound of the termite or white ant which is scattered in myriads over the veld. All the way to the Vaal he crosses only five rivers worthy of mention, namely, the Riet, the Modder, the Sand, the Vet, and the Valsch, and even these are a mere succession of pools for at least one half of the year. They do not occupy valleys, but flow in deep stone-strewn channels between high bush-fringed banks.

The country gets flatter and more arid as one proceeds westward from the railway, while it becomes more undulating and humid as one goes east, finally breaking up into hill and dale. The extreme west is one of the most dreary and barren regions imaginable, short of absolute desert, while the eastern border is as fair and fertile a region as could be wished.

When the European first entered this country from the south, he found it mainly occupied by the Bosjesman and the Koranna, though the Bantu or Kafir had already come down from the north and taken possession of portion of it. In those days the broad plains teemed with big game.

Now, the whole of this enormous area is parcelled out into farms averaging about 15 square miles in extent. The Bosjesman and Koranna are no more, the Kafir is reduced to a vassal and the game has mostly disappeared. The rooi-rhebok and the vaal-rhebok still hold out among the larger groups of kopjes, while the springbok, blesbok and gnu live on in the flats in a semi-protected state. Only the little stenbok and the diminutive duiker retain their full freedom.

The farmers are, of course, mainly Boers, but here and there one of British extraction is to be met with. The standard of living maintained by the Boer is similar to that of the labouring classes of London and other big towns, but his environment is infinitely better. To describe the contrast between the stifling atmosphere of a big town and the fresh air of the open veld, would be superfluous. He is often blamed for his unprogressiveness. But those who are aware

of the disheartening antagonism of many of the natural forces which surround him, will not so readily find fault. His sobriety is unparalleled and his hospitality proverbial.

Within the political boundary there are only two towns worthy of the designation, namely, Bloemfontein, the capital, and Kroonstad, a pleasure resort—both situated on the main railway—but there are quite a number of villages dotted over the country.

Bloemfontein is a plain, unattractive little town, covering an area of about a mile square. The streets are laid out parallel and at right angles to one another, the one series running east and west and the other north and south. It boasts, besides the House of Assembly or Raadzaal, and the Government buildings, an excellent sports ground, baths, a theatre, library, and museum, this last, however, being a very inadequate structure. There is also a park, but it is as yet in embryo.

By planting more trees and erecting a better class of house, it could be made, with its fine climate, a very pleasant place. This seems to have been recognised in planning the more recent additions on the outskirts of the town proper. The best scope for improvement is afforded at the north end, where the monotonous flatness of the surrounding bare veld is broken by a group of bush-covered kopjes. The town is already spreading out amongst these, and a superior style of house with large well-planted grounds is being built.

The population, like that of all the South African towns, is of a cosmopolitan character, with a prominent Jewish element. It numbers 15,500.

To the south of the town, and laid out on the same plan, and in continuation of it, is the Kafir location. The orderly arrangement and absence of crowding of the houses make it an exception and a model of its kind. The houses are of mud bricks, and contrast favourably with the usual corrugated-iron shanties. It has 18,000 odd inhabitants.

By adopting the geographic boundary one is enabled to enumerate one other town, namely, Kimberley. It is, however, even flatter, dustier and, apart from the famous diamond mines on which it is dependent, less interesting than Bloemfontein.

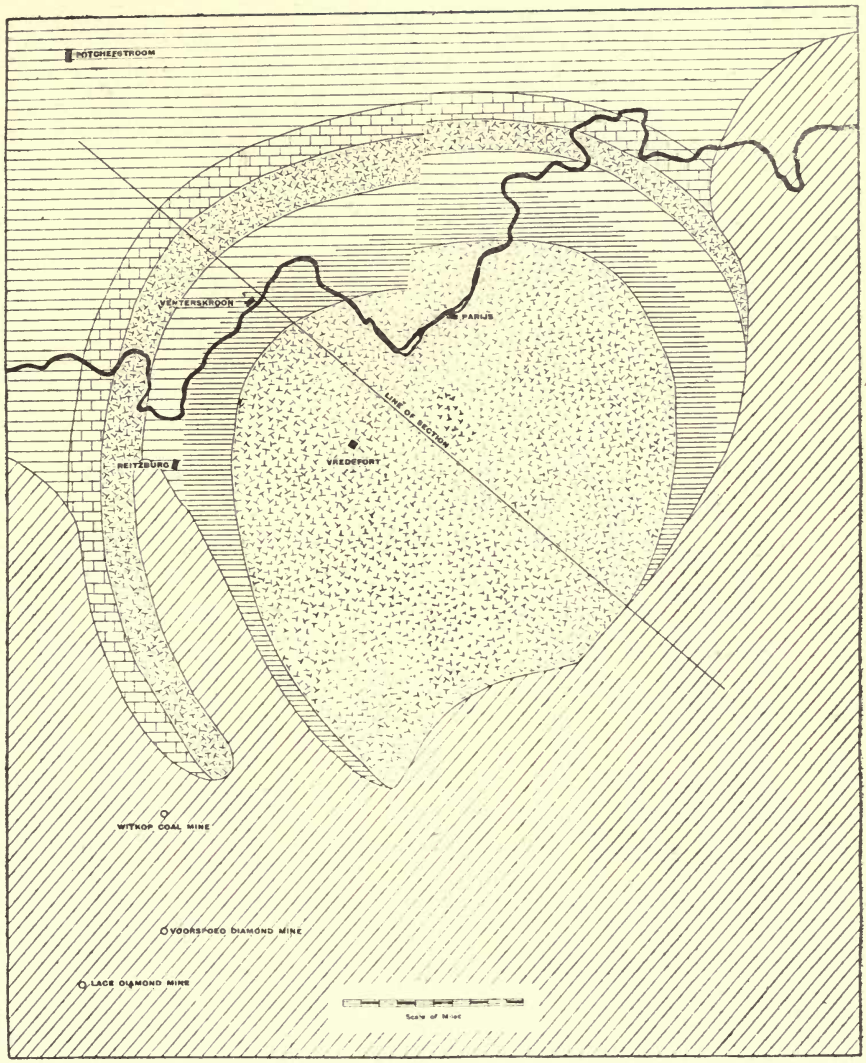
CHAPTER II.

STRATIGRAPHY.

Apart from some comparatively small outcrops of older formations along the Vaal river, the whole surface of Orangia is made up of the almost horizontal beds of the Karoo system.

The most extensive outcrop of the older formations is that in the neighbourhood of the village of Vredefort, where a complete sequence of the rocks of the Witwatersrand, Ventersdorp, and Potchefstroom systems is exposed, resting on the older South African granite. The area has been well-described by Molengraaff. It originated in the planing down by marine denudation of the top of a great anticline by which process the different rocks were brought to the surface in a series of concentric rings, the oldest being in the centre. Since then, in the northern half, atmospheric agencies have been at work on the upturned edges of these rocks, transforming the once level plain into alternating semicircles of hill and dale. In the southern half they are concealed beneath the beds of the Karoo system. The geological structure is well illustrated by the accompanying plan and section.

The granite occupies the centre of the area. It is mainly a biotite granite, with orthoclase, plagioclase, and microcline. It was formerly thought to be intrusive into the overlying quartzites and slates of the Witwatersrand system, there being some peculiar rocks, suggestive of contact metamorphism at the junction. Molengraaff says :—" Up to some distance from the granite the rocks are charged with contact minerals. From amongst these rocks I will quote two remarkable types : (1) apparently porphyritic more or less



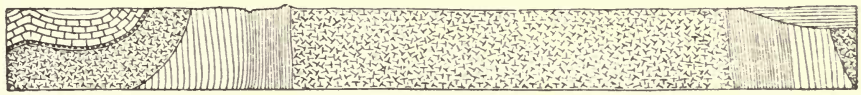


FIG. 1.—GEOLOGICAL MAP OF, AND SECTION THROUGH, THE COUNTRY AROUND VREDEFORT.

(1) Karoo Beds. (2) Pretoria Series. (3) Dolomite and Black Reef Series. (4) Ventersdorp Amygdaloids. (5) Upper Witwatersrand Beds. (6) Lower Witwatersrand Beds. (7) Granite.

schistose rocks, composed mainly of corundum and biotite in fairly large grains, connected by a network of quartz, (2) ferruginous and magnetic banded slate, charged with spherulites or bunches of actinolite. I found these two rocks to exist with great constancy and uniformity in the lower portions of the sedimentary formations around the greater part of the circumference of the granite." It is very probable, however, that they are older than the Witwatersrand beds, and that the latter rest unconformably, both on them and the granite.

The Witwatersrand system is split up into a Lower and Upper division, the former consisting mainly of slates and quartzites, and the latter of quartzites and conglomerates, but there is no sharp line of demarcation between the two. There is a peculiar belt in the lower division, of banded silica-iron oxide rock, consisting of alternating layers of quartz, jasper, hematite, and magnetite, which is frequently remarkably folded and faulted, and the laminæ minutely plicated, although the slates above and below are undisturbed.

The Ventersdorp system consists chiefly of basic aphanitic and porphyritic amygdaloids, but sediments are also represented. Hatch has described an interesting occurrence of coarse conglomerate, consisting of flattish pebbles or boulders of quartzite in a gritty matrix, on the farm Stinkhoutboom, south-west of the village of Reitzburg.

The rocks of the Potchefstroom system have been divided into (1) Black Reef series, (2) Dolomite series, and (3) Pretoria series. The Black Reef series consists of quartzites and conglomerates, but is poorly represented, and often absent in this district. Molengraaff describes the Dolomite series as consisting of alternating beds of dolomite and chert, the dolomite predominating in the lower and the chert in the upper portion of the series. The Pretoria series consists of quartzites and slates.

From the highest point on the granite, near Vredefort, a good insight into the geological structure, as reflected in the topography, can be obtained. To the south lies the flat or gently undulating country formed by the Karoo beds. To the west, north, and east are the semi-circular hill ranges constituted by the more resistant horizons of the older formations.

The hills immediately adjoining the granite show sharp crests and serrated outlines elongated in the direction of the general strike, and are composed of slates and quartzites belonging to the lower Witwatersrand beds.

Running parallel with these are the kopjes formed by the quartzites of the Upper Witwatersrand beds.

Beyond these again, and contrasting strongly with them, are the smooth rounded hills resulting from the weathering of the basic amygdaloids of the Ventersdorp system.

The Black Reef series is here too poorly developed to have any appreciable effect on the topography, while the Dolomite formation, which rarely gives rise to any elevations, occupies the broad valley between the last mentioned range and the final semi-circular ridge formed by the lowest quartzites of the Pretoria series.

South-west of the Vredefort area a long strip of the lavas of the Ventersdorp system is exposed along the river, while to the east there are other but smaller outcrops.

Some fifty miles east of Vredefort, in the angle between the Wilge and the Vaal rivers, there is a small inlier of the Lower Witwatersrand beds. A number of boreholes have been put down in the neighbourhood by Sawyer, in order to locate the base of the Upper Witwatersrand beds, which are there covered by the horizontal rocks of the Karoo system, and in the hope that, as on the Witwatersrand, payable auriferous conglomerates will be met with. The position of these boreholes is shown in the accompanying plan (Figure 2). The section revealed by boreholes No. 2, 4, and 8, which are ranged in a straight line, taken in conjunction with the small outcrop, is illustrated in Figure 3, and is of great interest. Borehole No. 9 is in progress at the time of writing. Figure 4 shows the three boreholes in greater detail.

An insight into the underground geology of the neighbourhood is afforded by the deep shafts of the Kimberley and De Beers mines. The sections exposed are represented in Figure 5. They shew the older granite overlain by sediments and lavas of the Ventersdorp system, and capped by Karoo shales with intrusive gabbrodiorite. The diamond mines of other localities have not been exploited to a sufficient depth to expose the rocks underlying the Karoo beds, but

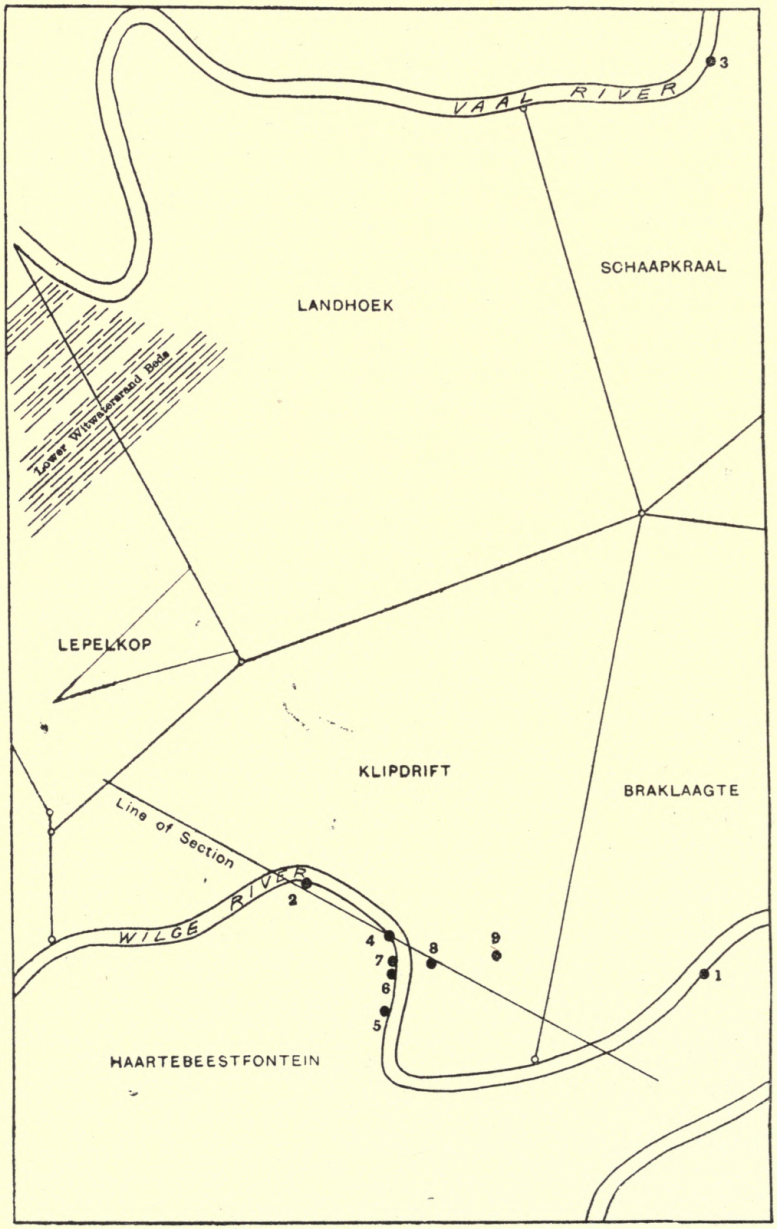


FIG. 2.—PLAN SHOWING POSITION OF BOREHOLES PUT DOWN ON WILGE RIVER BY SAWYER.

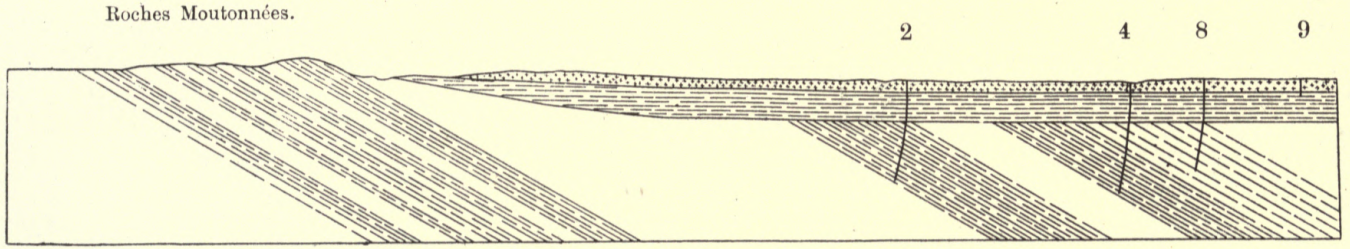


FIG. 3.—LINE OF SECTION PASSING THROUGH BOREHOLES SHOWN IN FIG. 2. (After Sawyer.)

Showing Slates and Quartzites of the Witwatersrand System partly overlain by the Shales, Sandstones, etc., of the Karoo System.

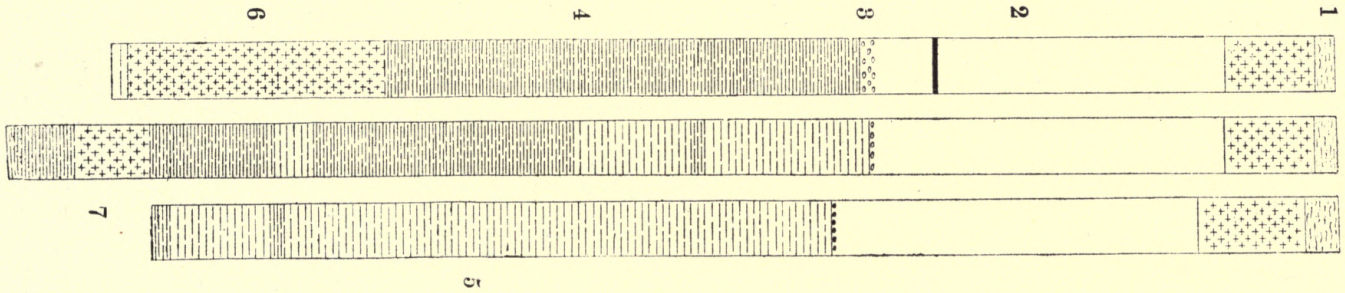


FIG. 4.—SECTIONS REVEALED BY DEEP BOREHOLES SHOWN IN FIG. 3.

(1) Surface Soil, (2) Sandstones and Shales of the Karoo (Ecca or Beaufort Series) System with Coal Seam and Gabbrodiorite Sill, and at base (3) Boulder-bed (Dwyka Series), (4) Slates of the Lower Witwatersrand Beds, (5) Quartzites of the Upper Witwatersrand Beds, and (6 and 7) Dykes. The lengths of the sections are (two) 1,747, (four) 1,900, and (eight) 1,690 feet.

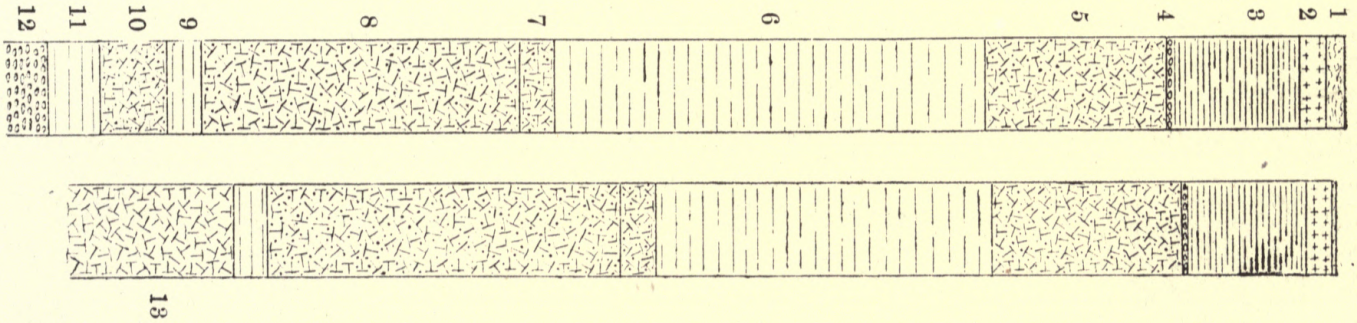


FIG. 5.—SECTIONS THROUGH THE SHAFTS OF THE KIMBERLEY AND DE BEERS MINES.

Surface Soil (1) 35 and 3 feet. Ecca or Beaufort Series, shale (3) 251 and 233 feet, with gabbrodiorite sill (2) 51 and 59 feet. Dwyka Series, boulder-bed (4) 6 and 2 feet. Ventersdorp Series, basic amygdaloid (5) 359 and 373 feet, quartzite (6) 826 and 632 feet, basic amygdaloid (7) 72 and 70 feet, quartz-porphyry (8) 621 and 687 feet, quartzite (9) 62 and 59 feet, quartz-porphyry (10) 41 feet, quartzite (11) 110 feet, conglomerate (12) exposed to 65 feet. Older granite (13) penetrated to 329 feet.

a clue to their nature is afforded by the boulders brought up from below with, and found in, the mine breccia.

The Karoo beds strike across Orangia in a south-west and north-east direction, and dip slightly to the south-east. They have been divided into Dwyka, Ecca or Beaufort, and Stormberg series.

The Dwyka series is represented by a band of boulder-shale which outcrops all along the north-western border of Orangia, using this term in the wider sense. Its true nature was first recognised by Stow who pointed out that it was nothing more or less than a glacier moraine. All along the Vaal river from its junction with the Orange to the village of Vereeniging, wherever the underlying rocks have been exposed by denudation, they are seen to be polished and seriated.

These underlying rocks, as already noted, are predominantly the hard aphanitic and porphyritic amygdaloids of the Ventersdorp system. They form gently undulating country which, notwithstanding the results of weathering, still present the characteristic contours of a glaciated region, and, in which, as might be expected, the present drainage system can be seen accommodating itself more or less to the glacially modified pre-Dwyka river valley. Occasionally, as at Pniel and Riverton, these surfaces consist largely of typical *roches moutonnées*. The evidence of the striations indicates that the general trend of the ice movement was from north-east to south-west.

The covering of moraine varies much in thickness with a maximum of about 30 feet. It consists of boulders and pebbles scattered haphazardly throughout a friable matrix. The boulders frequently exhibit typical striæ, and usually have characteristic glacial forms.

The Ecca or Beaufort series is made up of sandstones and shales, the latter predominating, and forms the surface of the greater part of Orangia. It is probably unconformable to the underlying series. It is about 1,500 feet in thickness, and is important on account of the valuable coal-seams which occur here and there towards its base. The largest deposit so far located is that of the Vereeniging coal-field, discovered by the geologist Stow. The lower beds have yielded a number of plant remains, for a knowledge of which we are indebted mainly to Leslie of Vereeniging. They comprise species of

Glossopteris, Gangamopteris, Cordaites, Sigillaria, Lepidodendron, Neuropteridium Bothrodendron, Psygmophyllum, Callipteridium and Schizoneura. Certain of the sandstones contain silicified wood in abundance.

Near Vereeniging there outcrops in the river bed a seam of coal through which project numerous casts of roots and stumps, still occupying their original positions, as well as the prostrate stems, of the trees that, with their predecessors, produced the material out of which the coal-seam was formed—a veritable fossil forest.

The Stormberg series, apart from some small outliers of the lower beds scattered along the central belt, is met with only along the eastern border of Orangia, and is probably unconformable to the underlying series. It comprises four well-marked subdivisions, namely, the Molteno beds, the Red beds, the Cave sandstone, and the Volcanic formation. Dornan gives the following thicknesses in two typical sections, just over the boundary :—

	Morija.	Thaba Tsuen
Volcanic Formation ...	—— ...	600 feet.
Cave Sandstone	200 ...	120 ,,
Red Beds	400 ...	300 ,,
Molteno Beds	500 ...	400 ,,

The full thickness of the Molteno beds is not exposed, but probably does not much exceed the amount in sight.

The Molteno beds are composed of sandstones and shales, the latter being subordinate. They contain thin seams and pockets of coal, but none of economic importance have been found in Orangia.

The basal sandstones are largely made up of granite débris, and are mostly coarse in texture, in both of which respects they differ from those of the underlying series. Large subangular pieces of felspar are frequently present, as also are fragments of garnet. These coarse-grained beds are sometimes succeeded by fine-grained aggregates of quartz and felspar in approximately equal proportions, which remind one forcibly of the peculiar Rooi Berg quartzites. Harger, who has carefully examined these beds from time to time, informs me that he has found at several widely separated places small isolated boulders of granite in them, which would seem to

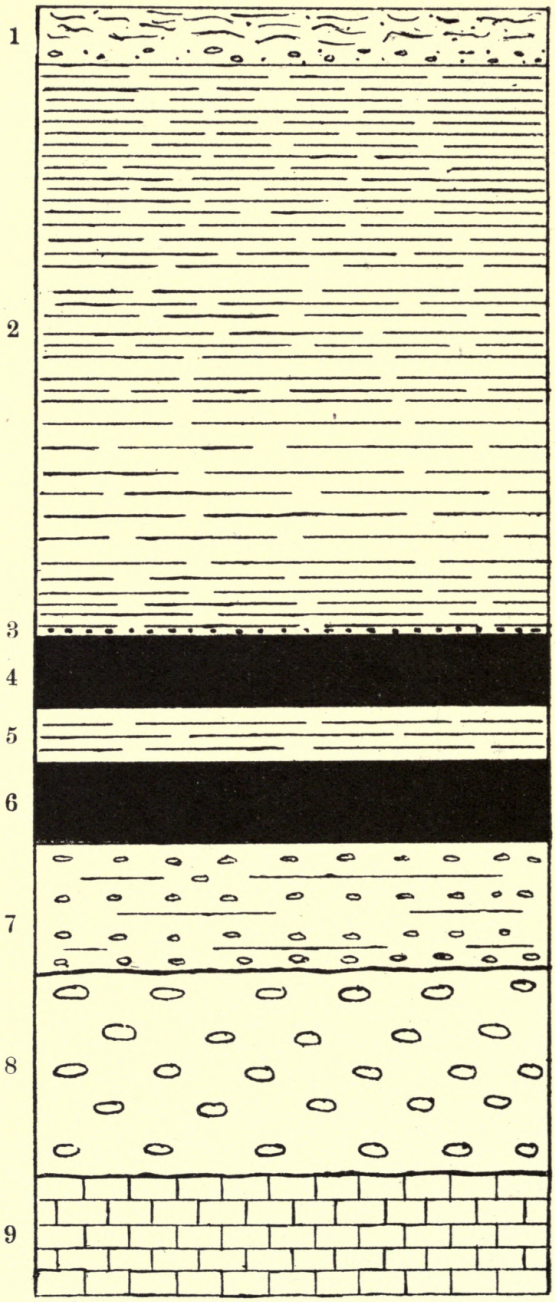


FIG. 6.—GENERALISED SECTION IN VEREENIGING COALFIELD. (After Leslie.)

Surface soil (1) with gravel containing silicified wood at base: 10 feet. Ecca or Beaufort Series, shales and sandstones (2), coarse-grained sandstone (3), coal seam (4), shale (5), coal-seam (6), stratified conglomerate (7): total thickness, 130 feet. Plant remains are found in the conglomerate underlying, and in the sandstones immediately overlying the coal seams. Dwyka Series, boulder-bed (8), 30 feet in thickness. Dolomite Series (9).

suggest the operation of some abnormal—possibly glacial—transporting agent, at that period.

The Red beds pass downwards into the Molteno beds, and upwards into the Cave sandstone. They consist mainly of soft bluish, greenish, and brownish red shales.

The Cave sandstone proper consists of a single thick bed of very fine-grained sandstone of a pale brown colour. It constitutes the capping of the numerous small plateaux and tafel-kops of the eastern border. The vertical sides of this capping are frequently weathered out into rock-shelters, and occasionally into caves, hence the name.

In the mountains which form the eastern boundary of Orangia, the Cave sandstone is overlain by the basic amygdaloids and tuffs of the Volcanic formation, which attains a thickness of as much as 4,000 feet.

The Stormberg series have yielded only a few fossils in Orangia. Outside of this area the Molteno beds contain abundant plant remains. The flora indicated, which includes the genera Thinnfeldia, Tæniopteris, Callipteridium, Baiera, Stenopteris, Chiropteris and Pterophyllum, but not Glossopteris, is very different to that from the base of the Ecca or Beaufort series. A few reptilian remains have also been found in them. The Red beds near Harrismith village include a bone breccia, specimens from which have been described by Owen. According to Draper the fossil fishes, Semionotus, Cleithrolepis, and Dictyopyge, described by Smith-Woodward from the neighbourhood of the villages of Ficksburg and Rouxville, come from the Cave sandstone.

The rocks of Orangia are traversed throughout the whole area by a network of basic dykes and sills of similar composition. Their constituent minerals are augite and lath-shaped plagioclases, usually in ophitic intergrowth, with subordinate olivine, ilmenite and, occasonally, garnet, the last two differing from those of the diamond-bearing rock in exhibiting their crystal forms. They are for the most part aphanitic or porphyritic in texture, but are usually phaneritic in the middle, and may therefore be classed as gabbro-diorites. Their remarkable similarity makes it probable that they are all of the same age. The sedimentary rocks are frequently sharply tilted and intensely indurated at the contact, the shales, for

instance, being converted into lydian-stone for a distance of several inches away. On account of their hardness, the larger dykes often form lines of bult, or even kopjes and randjes.

Newer than the gabbrodiorite intrusions, since they frequently break through them, are the almost equally widespread vein-like dykes and pipes of diamond-bearing rock, which will be described in the next chapter.

Diamonds, coal, and salt are the only minerals of economic importance that have been found in Orangia. Should the Vredefort granite prove to be intrusive into the surrounding strata, then one would be justified in searching for ore-occurrences in them. In any case, the peripheral belt of schists is worthy of investigation. Gold is widely disseminated throughout the Witwatersrand and associated rocks in minute quantities, and it is just possible, though not very probable, that some payable patches may yet be discovered. Oil has been met with here and there in the Karoo beds, but there is no reason for supposing it to be anywhere present in sufficient amount to be of industrial value.

Of useful rocks, the Karoo sandstones afford good building material, the matrix of the Dwyka boulder-shale is employed in the manufacture of pottery, and valuable bodies of limestone will probably be found associated with the dolomite formation.

CHAPTER III.

KIMBERLITE DYKES AND PIPES.

THE volcanic diamond-bearing rock, or kimberlite, of South Africa, has a wide distribution in Orangia. It occurs as the filling both of narrow fissures and of cylindrical vents or pipes. Seen *in situ* it is a hard greenish-blue rock, which weathers at the surface into a soft greenish-yellow substance.

The Roberts-Victor occurrence affords a representative example and, being best known to the writer, will be used here as a type. It consists of two small pipes situated on a fissure. The shales all around are much faulted and tilted sharply upwards. The contained rock is of at least two periods of formation. The older rock fills the fissure and part of the pipes, while the newer rock occurs in the pipes only, and consists of the smashed up remains of the older rock mixed with boulders of rock that have been torn off the sides of the vent at different depths.

At the time the writer was connected with the mine, the excavations had not reached the unoxidised blue ground, but were still in the oxidised zone or yellow ground. Further, only the older rock—and the richest portion of that—was then being worked, so that there is no risk of any distinctive features of the newer rock being attributed also to the older.

The older rock has the aspect of a friable sandy clay of fine texture, throughout which grains of red garnet, scales of brown mica, and fragments of green diopside, are somewhat sparingly distributed. The garnets are always surrounded by a thick rind of the radially fibrous alteration product known as kelyphite, and are sometimes completely converted into that substance.

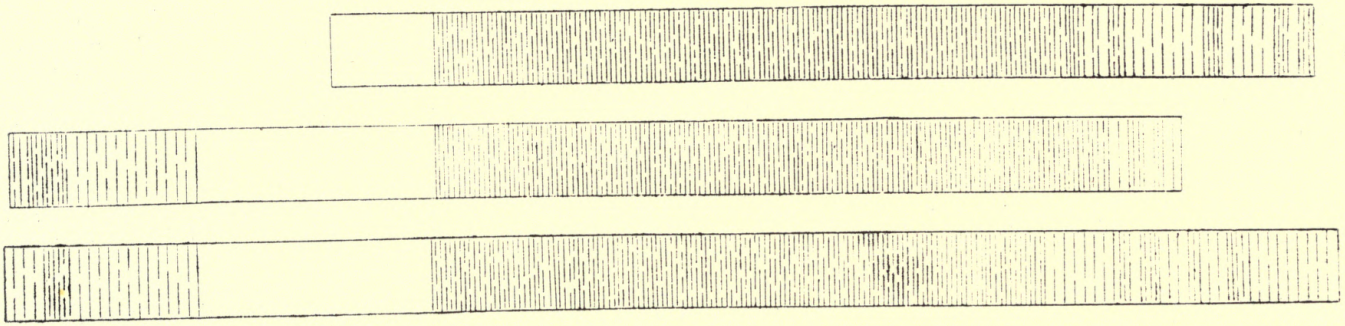


FIG. 7.—SECTIONS THROUGH SHALES AND SANDSTONES OF THE ECCA OR BEAUFORT SERIES FROM BOREHOLES SUNK ON KROONSTAD COMMONAGE.

The Blank Portion is the Coal Horizon, and is show in detail in Fig. 8. The lengths of the sections are 1,000, 1,194, and 1,343 feet respectively.

Somewhat plentifully scattered throughout this rock are irregular shaped lumps of the local shale. Boulders of similar shale, exhibiting concentric zoning, and of garnet-peridotite and garnet-pyroxenite occur, but are not common.

The concentrates remaining after the conversion of this rock into a thin mud by stirring with water, consist mainly of small well-rounded pieces of a greenish-blue slate or aphanite resembling a fine river gravel, and occasional rounded pieces of garnet-pyroxenite. Next in order of abundance are the garnets, and then fragments of diopside. Olivine, ilmenite, mica, enstatite, kyanite, chromite, and diamond occur in comparatively small quantity. Of these minerals only the last two exhibit their crystal form.*

The diamonds occur mostly as beautiful little octahedra, often distorted and usually with characteristically curved faces. The faces are commonly more or less etched, and often exhibit groups of triangles, both impressed and in relief, while the curve is sometimes replaced by a pyramid built up of concentric triangles. A number of the octahedra, however, have perfectly plane and smooth faces and enclose a colourless cube or, in the case of hemihedral examples, pyramid. Octahedra joined together in various combinations not infrequently occur. Macles are not uncommon, but other hemihedral forms are rare. The diamonds also occur in some instances as grains, and, in small quantity, as irregularly shaped masses ("boart") and splinters. In some cases groups of minute octahedra, similarly orientated, are attached to one or more faces of a crystal.

The garnet-peridotite (lherzolite) and garnet-pyroxenite (eclogite) boulders are of considerable interest. They are the largest in the mine, averaging from half a foot to two feet in largest diameter. They contain in proportionate abundance all the characteristic minerals of the kimberlite.

The readily decomposable garnet-peridotites, having suffered considerably from lying within the zone of oxidation, are barely

* Only in regard to the harder minerals does this reflect the relative abundance in the rock. Mica, which naturally does not appear in any quantity in the concentrates, is perhaps the most abundant megascopic mineral in the rock; while, as will be seen later, olivine, now serpentinized and decomposed, is probably the dominant mineral.

recognisable. Young has described (Trans. Geol. Soc. S. Africa, IX., p. 121) the microscopic characters of two thin sections from such boulders :—"They are mainly composed of serpentinous, chloritic, calcitic, and ferruginous material, retaining the outlines of the original olivine and pyroxenes, as well as traces of the cleavage planes. In No. 509, fairly fresh crystals of a pyroxene (diopside?) are present. In the fragment of No. 511, from which the slice was cut, ilmenite, and a few garnets can be seen."

Even the more resistant garnet-pyroxenites are, as a rule, much altered. The commonest form consists of brownish-red clouded garnets, in an opaque dark green matrix. In some cases the garnets, and in others the matrix, are dominant. Young has described the microscopic characters of a thin section from one such boulder, as follows :—"No. 508 is in an advanced stage of decomposition, and its original character is difficult to determine. The most conspicuous mineral is garnet in large irregular grains, which are corroded along the borders and some of the cleavage cracks. The grains are surrounded by a thin kelyphitic border, composed of hornblende. Outside this is a zone containing small crystals of plagioclase, grains of ironstone, flakes of biotite, and small grains of another undetermined mineral. Beyond this zone are shadows of some coarse-grained mineral which is almost entirely decomposed to cryptocrystalline matter." This last is the dark green matrix above referred to.

Other varieties of garnet-pyroxenite—some exceedingly handsome—occur in the portion of the mine under consideration. The following are descriptions of some selected specimens :—

No. 504. Portion of a tabular banded boulder. The main mass consists of blue kyanite scattered throughout a pale bluish-grey matrix. A band mainly of much clouded reddish-brown garnets forms the margin. A thin section under the microscope shows several grains of kyanite and one or two of garnet surrounded by large individuals of some mineral which has been altered to cryptocrystalline matter. In some cases these last contain fragments of the original mineral, which is colourless and possesses brilliant polarisation tints (pyroxene?); while in others, traces remain in the shape of faint cleavage lines. The kyanite, which is always twinned, shows characteristic cleavage, and, being apparently

colourless, is not visibly pleochroic. The garnets show typical cracks. Both the kyanite and garnet are surrounded by decomposition zones.

No. 505. Also portion of a tabular banded boulder. The main mass consists of colourless and bluish-red garnets, scattered throughout a holocrystalline matrix of semitranslucent grass-green diopside. The garnets are subordinate and elongated in the direction of banding. At the outside edge there is a margin about two centimetres

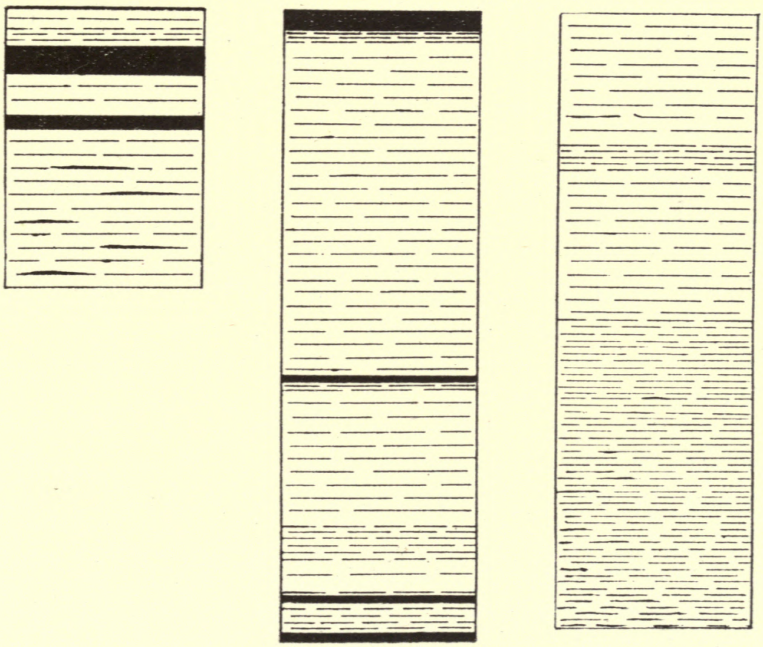


FIG. 8.—DETAILED SECTION OF COAL HORIZON ENCOUNTERED IN BOREHOLES SHOWN IN FIG. 7.

thick where garnets predominate, and vary from colourless to smoky grey and pale brown. There is a string of ilmenite granules at the junction of this zone with the main mass. A thin section, under the microscope, shows in one case an interesting intergrowth of garnet with diopside, the garnet occurring as laths along the cleavage planes of the pyroxene prism, but no other features of special interest.

No. 506. Blue kyanite and brown garnets scattered throughout a pale grey matrix. Microscopically it consists of a holocrystalline aggregate of kyanite, garnet and cryptocrystalline individuals. These last do not show any traces of the original mineral. The garnets in some cases enclose round grains of kyanite. The kyanite and garnet are surrounded by decomposition zones.

No. 507. A holocrystalline aggregate of red garnets and translucent dark green diopside. The latter traversed by a network of opaque decomposition lines. A thin section, under the microscope, shows no special features.

There are some features presented by these boulders that have an important bearing on the question of their origin. They are: (*a*) The boulders have a polished and often striated exterior, the grains of garnet in the margin being frequently worn down to half or more of their original diameter, (*b*) Large isolated pieces of boulders, the corners of which are often quite unabraided, are of not infrequent occurrence, (*c*) Many of the boulders are more or less tabular, some are quite rectangular—the edges, however, being rounded—and most show a distinctly banded structure, the banding being always linear and never concentric.

I have not had the same opportunities of investigating the newer rock, but it was exposed to a certain extent, through previous prospecting operations, at the time I was connected with the property.

The most striking feature is the great abundance in it of various rocks that have been torn off the sides of the vent at different depths. They are mostly well-rounded and smoothed, but a small proportion are subangular. The most abundant are boulders and pebbles of a peculiar felspar-porphyry. Other rocks represented are quartzite, granite, syenite, and many obviously ancient green and grey aphanites, both amygdaloidal and porphyritic. Garnet-pyroxenites also occur, but are comparatively rare.

There was a good section exhibited in the northern pipe, where the columnar distribution of the boulders was well shown. It was very evident that these had been violently erupted through the older rock.

In this connection it would be interesting to know whether a

larger number of broken diamonds are found in the newer rock. A considerable proportion of the diamonds from the Kimberley, the Voorspoed, and the Premier pipes are broken.

The output of the Roberts-Victor mine has been as follows :—

		Loads.	Carats.
1906 ...	July to December	29,259 ...	19,896
1907 ...	January to June ...	83,212 ...	55,066
1907 ...	July to December	168,751 ...	77,751
1908 ...	January to June ...	65,373 ...	30,964
1908 ...	June to December	164,679 ...	58,815
		511,274	242,492

The nature of the diamond-bearing rock of South Africa is still very imperfectly known. The rock of some fissures gives one the impression of being a consolidated igneous rock, while that of others has all the appearance of a purely fragmental rock.

There are two narrow fissure occurrences in the neighbourhood of the Roberts-Victor mine. The one is situated on Blauwboschfontein and the other on Biesjesfontein, both of which farms are shown on the accompanying plan (Figure 9). The three occurrences are arranged in an almost straight line, and probably lie in a zone of fracture. This last is almost certainly the case with the Roberts-Victor and Biesjesdam occurrences, since they are both skirted on the north-west by the same gabbrodiorite dyke. The rock of both fissures closely resembles that of the Roberts-Victor, except that it is mostly very hard, even at the outcrop.

A hand specimen of the Blauwboschfontein rock which I have before me at the time of writing, shows scales of greenish-brown mica, averaging about two millimetres in diameter, scattered haphazardly throughout a bluish-grey aphanitic matrix, containing abundant specks of the same mineral, an ilmenite grain, and here and there a red garnet and green diopside. There are also many round calcareous masses resembling amygdales.

Two thin sections (Nos. 510 and 511) from this specimen, when examined under the microscope, present the aspect of a completely

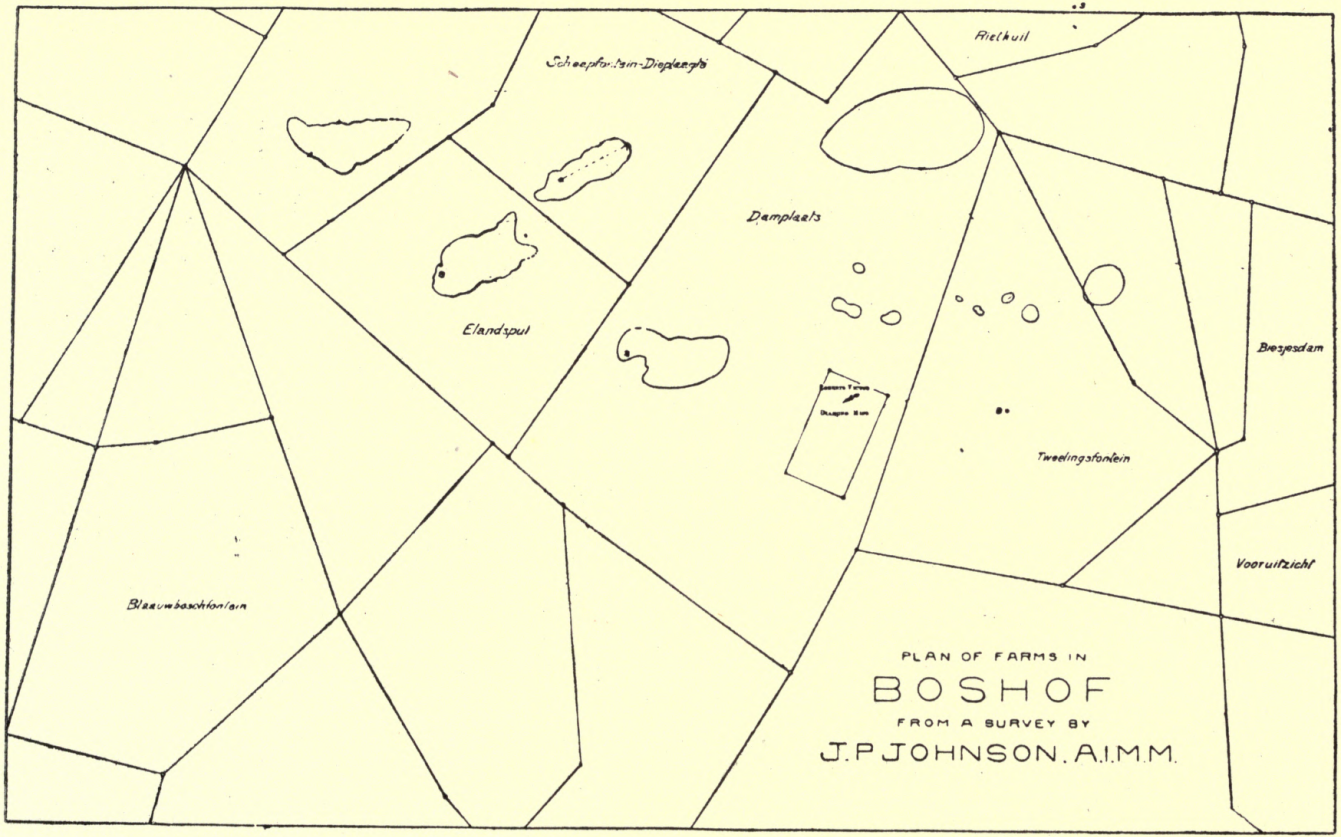


FIG. 9.—PLAN SHOWING SOLUTRIC SITES NEAR BOSHOF.
Base-line in Schaapfontein-Dieplaagte Pan = 1294·310 Metres.

altered fragmental rock. The most conspicuous mineral is a mica which occurs in scales with hexagonal basal sections strongly pleochroic (ranging from green to a very light brownish-yellow). There is much calcite and probably dolomite, also some quartz and iron oxide.

A typical sample of the Biesjesdam rock in my possession shows sparsely scattered scales of a dark brown mica ranging from about 4 to 5 millimetres in length, and occasional grains of red garnet and green diopside embedded in a brown aphanitic groundmass. There are numerous amygdale-like bodies of dolomite or calcite and sometimes of quartz, but without any directional arrangement.

A couple of thin sections (Nos. 501 and 502) of this rock show it to be microscopically similar to the Blauwboschfontein rock, but the calcite (or dolomite) is in large individuals enclosing the other constituents. The amygdale-like bodies are peculiar, being composed of dolomite or calcite, with well crystallized quartz prisms especially round the margins. In No. 501, one of the amygdale-like bodies contains a few scales of green mica. A vein of dolomite or calcite runs through the same section.

In spite of the narrowness of the fissure, the rock contains numerous well-rounded pebbles and boulders, some as much as half a foot in diameter. They include granite, quartzite, grey and green amygdaloidal aphanites and garnet-pyroxenite. A distinctive feature is the comparatively large size attained by the mica and diopside.

The extreme alteration revealed by the above described microscopic examination is characteristic of kimberlite wherever it is found, and is the chief cause of the obscurity surrounding its nature.

Toit, after an exhaustive investigation of the Kimberley group of pipes, where there are splendid opportunities of studying the rock in depth, considers that kimberlite has been produced by the shattering of various deep-seated basic and ultrabasic (felspar-less) rocks and the incorporation of the resulting débris by a magma of ultrabasic character.

A typical hand-specimen of the blue-ground from the Kimberley mines would show small rounded and angular fragments of various rocks embedded in an aphanitic matrix, in which pieces of serpen-

tinised olivine, enstatite and diopside, grains of garnet and ilmenite and scales of brown mica, are prominent.

Under the microscope this matrix sometimes has a fragmental aspect, and at others it has somewhat the appearance of an igneous rock, but usually the constituents are too decomposed for recognition. Serpentinised olivine, sometimes showing sharp crystal outlines, is probably the dominant mineral in this matrix.

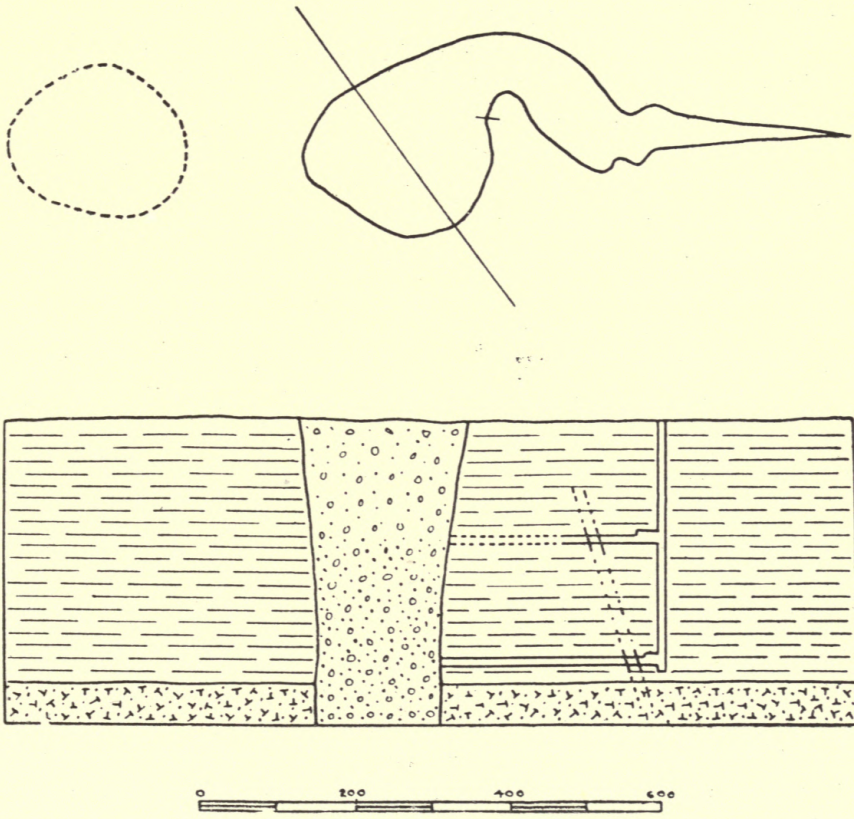
The shape of the pipes show that they are the result of sudden and violent explosions. Much of the débris ejected during the outburst would fall back into the pipe, and the more resistant pieces would become rounded by movement in it. If Toit's conception be correct, an ultrabasic lava then welled up the pipe, incorporated the boulders, and finally consolidated as kimberlite.

The absence of clear evidence of contact metamorphism of either the walls of the vent or of the included fragments of rock, is surprising. The effects of high temperatures are plainly seen in the Theron and Paardeberg-East mines and, to a lesser degree, in Kamfersdam, but may be due to hydrothermal action. Many mines, as, for instance, Wesselton, show no signs of the action of heat. If the kimberlite ground-mass is a consolidated lava, it is clear that it must have been of an exceptional kind. It could not have been a molten rock, but must have been more of the nature of a hot mud.

Corstorphine, however, maintains that the filling of the pipes is not an igneous rock but a breccia derived from an igneous rock that solidified in depth.

The writer's impression is that the typical fissure kimberlite which is a hard, dark-coloured, aphanitic rock, containing much visible mica and occasional megascopic garnet, ilmenite, diopside and olivine, and comparatively few inclusions of foreign rock, is a magmatic intrusion, and that the pipes were originally filled, and perhaps on more than one occasion, with a similar magma, which, except near the depth of origin, must have had a very low temperature for an igneous extrusion, and which, after solidification, was smashed up by frequently repeated explosions.

The garnet-peridotite and garnet-pyroxenite boulders have excited much interest from time to time. Their similarity in mineral



SCALE OF FEET.

FIG. 10.—PLAN AND SECTION OF THE ROBERTS-VICTOR DIAMOND MINE, THE LATTER SHOWING TWO KIMBERLITE DYKES. (After Melvill.)

The outline of the smaller pipe is not known accurately.

constitution to the matrix in which they are found suggests a genetic relationship.

It is true that only two instances of the occurrence of diamonds in them have been recorded, namely, the oft-quoted discovery by Bonney of ten small diamonds in two boulders from the Newlands mine, and the more recent discovery recorded by Corstorphine of sixteen diamonds in a boulder from the Roberts-Victor. But this is not surprising when one remembers the variable distribution of the diamonds in a mine, and that the richest portion of the Roberts-Victor mine yielded only one carat per load (16 cubic feet) of a matrix so easy of thorough examination. To examine an equal bulk of boulders they would have to be chemically reduced to the same degree of incoherence, but this has not yet been achieved. To mechanically reduce them to the required fineness would be to pulverise the diamonds also. The chances of exposing a diamond by breaking open boulders are obviously extremely small. Interesting in this connection, too, is the occurrence of graphite in similar boulders from Jagersfontein.

The writer believes that the garnet-peridotite and garnet-pyroxenite boulders, as well as the bulk of the megascopic minerals, are derived from a portion of the same magma that solidified in depth as a coarse-grained plutonic rock, prior to the formation of the fissures and pipes, but that it is necessary to distinguish between the genetically related boulders and similar rocks of metamorphic nature that are associated with them. To this last category the writer would refer Nos. 508, 509 and 506, described from the Roberts-Victor mine; the first and third of these have been found constituting one and the same boulder, while the second is merely a variety of the third.

Corstorphine, however, considers the garnet-peridotite and garnet-pyroxenite boulders to have been segregations. "The precise character of the magma as it solidified in depth we do not know. In it there were coarser and finer grained portions; aggregates of one or more of the constituent minerals; segregation nodules and segregation veins—all these being represented in the breccia."

CHAPTER IV.

DIAMOND MINES.

WHILE the different occurrences of kimberlite bear a remarkable resemblance for a volcanic breccia, showing that they are all derived from the same magma, yet each group possesses a distinct facies, due to such factors as variation in the tint of the garnets and in the size and proportion of the different mineral constituents, which, however, is not always easy to describe.

Lion Hill is a characteristic tafel-kop of gabbrodiorite situated at the side of the main railway some sixty miles south-west of Kroonstad. It is penetrated in a west and east direction by a series of kimberlite veins, one of which extends right across. This line of fissuring has been traced for a distance of nine miles, and three pipes have been located on it (see Figure 11).

The Wynandsfontein pipe lies some three and a half miles to the east of the hill, and has an area of about 90 claims. The Vergelegen pipe is located about three-quarters of a mile west of the hill and comprises 150 claims. The Welverdiend pipe lies nearly five miles further west, and measures only 40 claims. A claim, it should be mentioned, measures 31 by 31 feet.

The relative proportions of garnet and ilmenite in these pipes is noteworthy. At Wynandsfontein ilmenite is abundant and garnet scarce, while the reverse is the case at Welverdiend. The following are some particulars of the different mines.

The Welgegund (Driekopjes) mine is situated about four miles north-north-west of the Welverdiend pipe, and has an area of 55 claims. The pipe reaches the surface through a thick gabbrodiorite sill, which forms the walls to the depth at present reached by the workings.

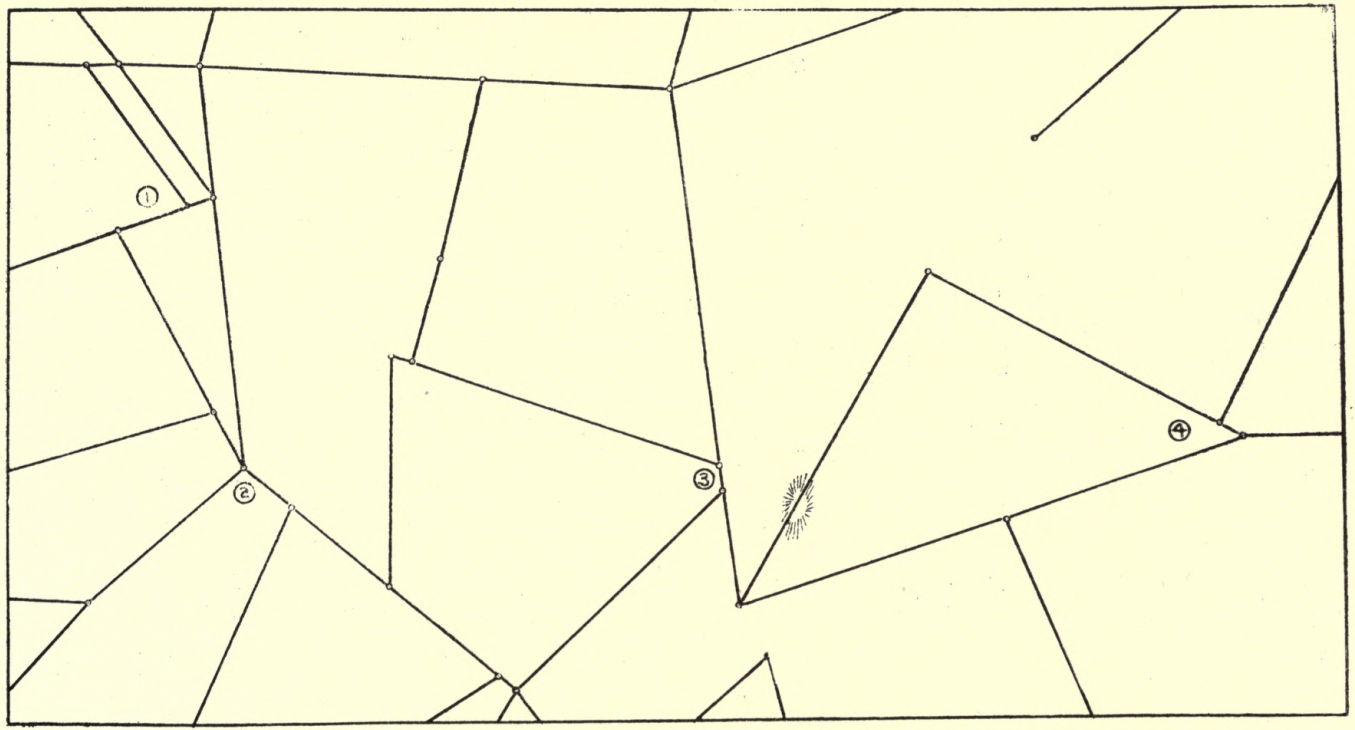


FIG. 11.—PLAN OF LION HILL GROUP OF PIPES.

(1) Welgegund. (2) Welverdiend. (3) Vergelegen. (4) Wynandsfontein.

At the time I visited the mine the bottom was covered with water, so that only the yellow ground was exposed.

The rock resembles that of the Roberts-Victor, already described, in its broader features, but a considerable proportion of the constituent minerals are larger. The average garnet of the Roberts-Victor, for instance, resembles a pea in size and shape, while that of the Welgegund is like a broad-bean in those respects.

Irregular masses of the local gabbrodiorite and rounded boulders of indurated shale are scattered throughout. Boulders of either garnet-peridotite or garnet-pyroxenite were evidently rare or absent. The boulders of indurated shale frequently exhibit concentric lamination, as also did two pebbles of quartzite.

The concentrates show the same peculiar resemblance to a fine river gravel, and consist mainly of rounded and subangular pieces of slate (or aphanite) and gabbrodiorite (different to that of the walls) in about equal proportions.

Several dyke-like bands of the breccia penetrate the surrounding rock along joint planes. At the north-east margin of the pipe there is a well-marked column of boulders.

About twenty miles north-east of the Welgegund is the Kaalvallei mine.

The Monastery mine lies about 35 miles south-east of the village of Winburg. It consists of two small pipes, situated on a fissure, and is noted for the large size attained by many of the constituent minerals. Among the boulders are numerous examples of a peculiar magnetite-pyroxenite, the two components of which are in graphic intergrowth.

The Ebenhaezer and Koffyfontein mines adjoin one another and contain 526 and 1,450 claims respectively. The latter, which may be described as a large pipe, has been producing diamonds since 1899. Though the yield of carats per load is low the quality of the diamonds is above the average. The output, which is mostly from Koffyfontein, has been as follows :—

	Loads.	Carats.
1898-1899	997,339 ...	40,170
1899-1900	577,070 ...	30,564
1900-1	305,269 ...	16,847

	Loads.	Carats.
1901-2	——— ...	2,442
1902-3	312,641 ...	16,738
1903-4	469,289 ...	22,394
1904-5	616,883 ...	30,989
1905-6	703,832 ...	33,340
1906-7	664,192 ...	31,604
July to December, 1907	672,445 ...	25,150
January to June, 1908	664,756 ...	32,517

As shown in the accompanying plan (Figure 12) there are several other pipes in the vicinity.

The Jagersfontein mine lies about 35 miles south-east of Koffyfontein. It is a large pipe of 1,124 claims. It has been producing diamonds since 1898, and has been worked opencast to a depth of 500 feet. It contains a large number of garnet-pyroxenite boulders. It is famous for the size and quality of its diamonds, the largest so far found being the Excelsior, which weighed 971 carats. The output has been as follows :

	Loads.	Carats.
1898-9	2,768,082 ...	288,937
1899-0	1,670,935 ...	183,349
1900-1	156,359 ...	18,002
1902-3	365,624 ...	29,302
1903-4	1,836,634 ...	167,598
1904-5	2,769,320 ...	266,225
1905-6	2,709,819 ...	255,841
1906-7	2,405,581 ...	219,275

The Lace mine lies about sixteen miles north-west of Kroonstad, and has an area of 400 claims. The output of diamonds has been as follows :—

	Loads.	Carats.
1902	142,060 ...	16,562
1903	313,483 ...	33,846
1904	148,234 ...	20,029
1905-6	239,647 ...	27,922
1907	367,057 ...	41,420

The Voorspoed mine is situated some five miles north-east of the Lace. With the exception of the Premier, it is the only large payable diamond mine that has been discovered during the last seventeen years. Mr. Harger, the well-known expert on diamond prospects and mines, has kindly favoured me with the following description of it.

"The formation surrounding the pipe consists mainly of shales, but these are overlain on the north-eastern edge of the mine by felspathic sandstones. These form the wall of the mine for about one-third of its circumference, a basic amygdaloidal aphanite constituting the remainder.

"The diamondiferous portion of Voorspoed pipe covers about 800 claims, but at one time, the writer (who was the discoverer) anticipated it would cover fully 1,500 claims, for the reason that the

ERRATUM.

Page 32, line 13.—For 1898, read 1878.

er. It was known that a within the rim rock con- out as a huge mass nearly middle of the mine, and was hoped the remainder would therefore be "reef" rock, and give place to kimberlite underneath, as happened in nearly all the largest mines, to wit, Dutoitspan, Bultfontein, Jagersfontein and Wesselton. Such, however, was not the case. On the southern portion, which consists entirely of aphanite with little patches and veinlets of kimberlite in it, several boreholes were put down, but none of them passed through the aphanite, the greatest depth reached being 600 feet. The eastern portion was similar, the aphanite having apparently been much fractured, and containing patches of kimberlite in several places, whilst in another the aphanite and kimberlite were indiscriminately mixed up.

On the southern portion a fissure containing highly micaceous kimberlite (free from pebbles and boulders) was met with in two places, striking roughly east-west. The ground in these cases was typical fissure ground. In close proximity, however, was a patch several claims in extent of kimberlite, containing boulders and pebbles, and in all respects resembling the pipe kimberlite.

In addition to the masses of aphanite referred to, which occupy

	Loads.	Carats.
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"The diamondiferous portion of Voorspoed pipe covers about 800 claims, but at one time, the writer (who was the discoverer) anticipated it would cover fully 1,500 claims, for the reason that the area within the shales equalled that number. It was known that a considerable area on the south and east within the rim rock consisted of the aphanite already referred to, but as a huge mass nearly fifty feet in thickness also lay in the middle of the mine, and proved to be merely a 'floating' mass, it was hoped the remainder would likewise be 'float' rock, and give place to kimberlite underneath, as happened in nearly all the largest mines, to wit, Dutoitspan, Bultfontein, Jagersfontein and Wesselton. Such, however, was not the case. On the southern portion, which consists entirely of aphanite with little patches and veinlets of kimberlite in it, several boreholes were put down, but none of them passed through the aphanite, the greatest depth reached being 600 feet. The eastern portion was similar, the aphanite having apparently been much fractured, and containing patches of kimberlite in several places, whilst in another the aphanite and kimberlite were indiscriminately mixed up.

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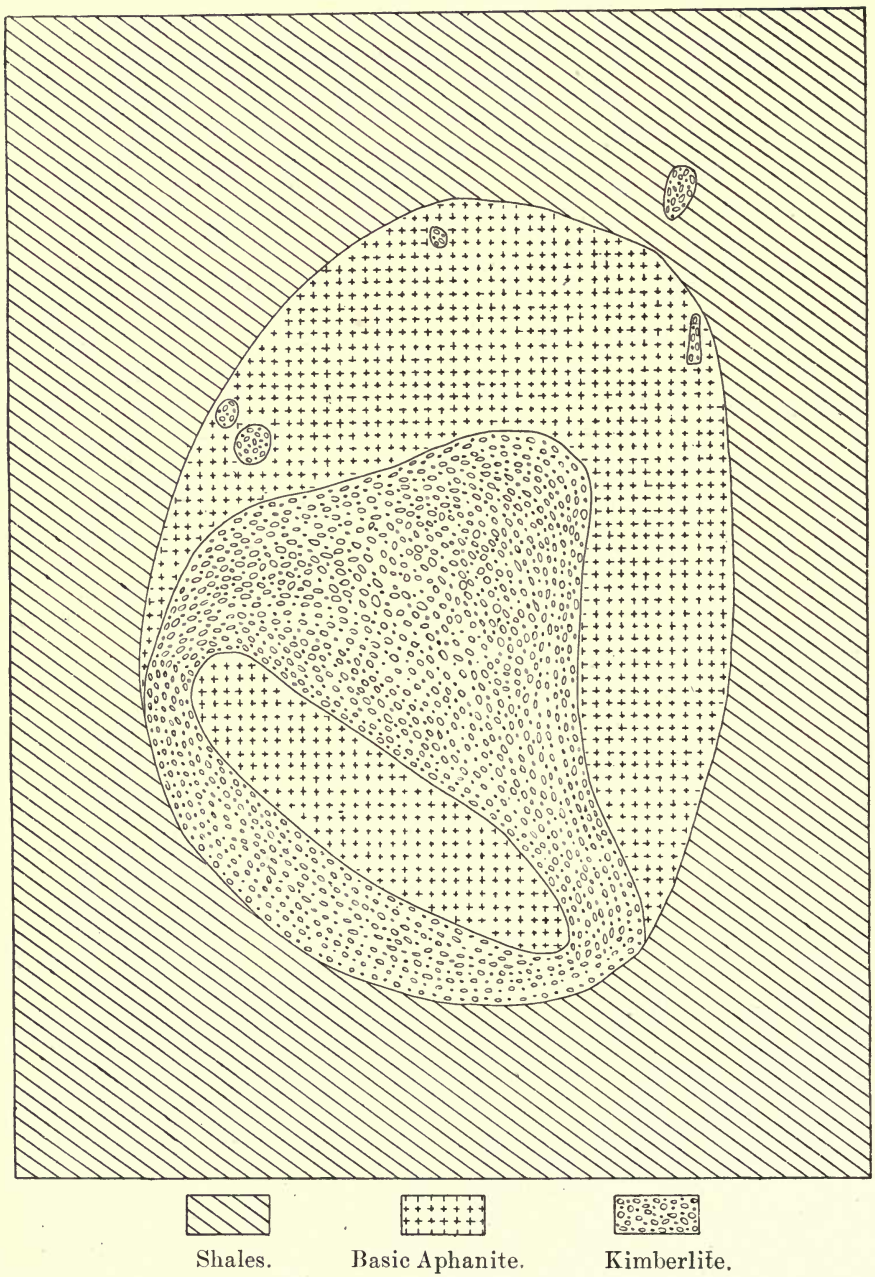


FIG. 46.—PLAN OF VOORSPOED PIPE. (*After Harger.*)

an area of nearly 700 claims, the mine ground, wherever met with, contains a very noticeable amount of the aphanite throughout, varying in size from microscopic dust to huge masses. In almost any hand specimen the presence of the aphanite can be detected, either with the naked eye or a lens.

After a careful study of all the evidence obtained, the conclusion arrived at by the writer is that we have here a unique occurrence of a volcanic diamond pipe within the neck of a pre-existing volcano, the stump of which alone remains owing to denudation. The shape of the entire occurrence within the shales, as we see it to-day, is almost truly oval, and occupies about 1,500 claims. The intrusions of kimberlite appear to have blown out more than half of the older volcanic filling, but failed to displace the remainder. The explosive forces, however, shattered the remaining aphanite in all directions, filling many cracks with kimberlite and in several places forcing out masses of rock several claims in extent, and replacing it with a true kimberlite or serpentine breccia. The tilting of the shales at the contact all round the aphanite, proves the rock to be intrusive, although owing to weathering no evidence of metamorphism was observable in the shales. The presence of shale and sandstone forming a complete girdle around the aphanite and kimberlite shows that the occurrence is not a big dyke. It forms to-day a roughly crescent shaped mass around three sides of the mine between the diamondiferous kimberlite and the shales, and is evidently a solid vertical column of aphanite, representing portions of an extinct volcanic neck, or, in any case, a pipe-like intrusion of a related kind.

"The rock itself consists of a greyish green basic aphanite, amygdaloidal in character. A few blocks found loose in the kimberlite are highly vesicular, and contain almost fifty per cent. of white heulandite and calcite—the former predominating, but the solid column of aphanite, tested to a depth of 600 feet, is but slightly vesicular in character, and contains much smaller amygdales, wh lst the zeolites are replaced by calcite. Some of the cavities have been only partially filled, and contain much dull green chloritic matter, while an occasional speck of copper was observed. Under the microscope a thin section shows the felspars, which are lath-shaped, to range between andesine and labradorite, the interstices

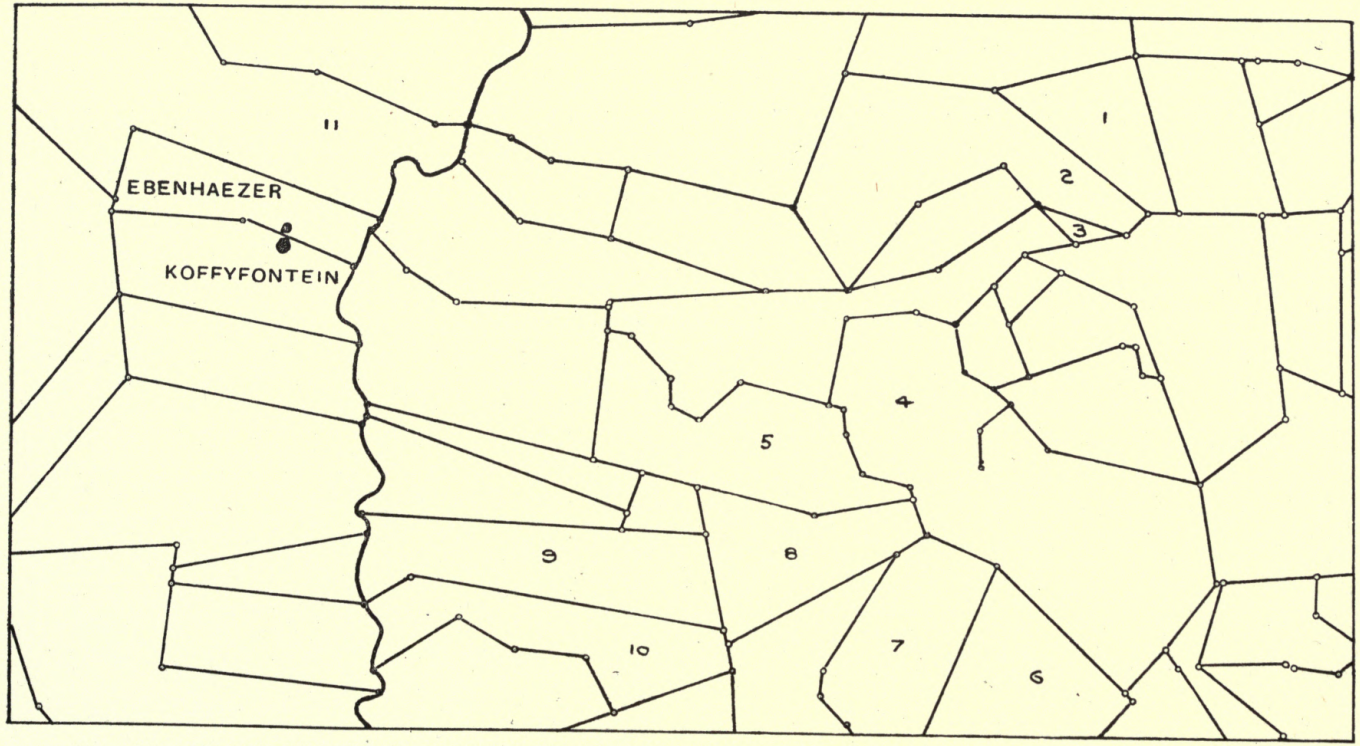


FIG. 12.—PLAN SHOWING DISTRIBUTION OF DIAMONDIFEROUS DYKES AND PIPES NEAR KOFFYFONTEIN.

(1) Holpan, (2) Vaalpan, (3) Nooitgedacht, (4) Vandermerwesdam, (5) Ruigtepoort, (6) Zwartrandsdam, (7) Tafelbergdam, (8) Twyfelhoek, (9) Secretariskop, (10) Tafelkop, (11) Klipfontein.

between the plagioclases being partly filled with chloritic alteration products, and also with a greenish almost isotropic aggregate, containing acicular felspar microlites. Some serpentine pseudomorphs also occur, shaped like basal olivine sections, and the usual iron oxide accessories were plentiful.

"Like almost every similar occurrence, the Voorspoed pipe lies on a line of weakness occupied by a fissure containing kimberlite, and this has been traced and opened up for four miles. This fissure was formed before the diamond pipe, as it is found dissecting the country rock right up to the wall of the mine, but not *within* it. The fissure, however, like the pipe, is evidently younger than the aphanite, as a fissure with similar strike (and probably an offshoot of it) can be seen traversing the aphanite, which forms the southern wall of the mine. The fissure ground is of the micaceous variety, very fine in texture, and containing no megascopic minerals, except a few garnets with kelyphite coatings. In places, however, it contains roundish pebbles and boulders, usually of quartzite. The latter appears to have resulted from the metamorphism of sandstone, as evidenced by the much corroded exterior of the pebbles, to which small flakes of mica adhere tightly; their concentric zoning and cracking, silicification of the quartz grains, and alteration of felspars, are all probably due to the heat of the magma in which they had been caught during its passage upwards. Similar heat phenomena occur in other fissures or dykes known to the writer, but have not been observed in any of the large pipes.

"The ground in the pipe differs entirely from that in the fissure. In the central portion of the mine the ground is bright yellow in colour, rough and pebbly, and rather full of very small mica. It contains about fifty per cent. of round and oval-shaped pebbles, and small boulders, the latter consisting of aphanite, granites, dolomite, quartzite, Dwyka conglomerate, etc. Ultra-basic rocks such as eclogite, lherzolite, and pyroxenite, are either entirely absent or extremely rare—not having been met with by the writer.

"The most interesting boulders found, however, consist of a felspar-garnet rock, quite different to anything the writer has met with in other diamond mines: this occurs both as a coarse and medium crystalline granular rock, in which usually from one-third

to half of the rock consists of much cracked, pale, clouded, mauve coloured garnets, attaining at times a diameter of nearly quarter of an inch, and contains flakes of graphite. A thin section made from the same rock, but of finer texture than the above, was examined by Mr. Weber, of Johannesburg, who found it to be made up principally of white perthitic felspar, garnet, quartz, and monoclinic pyroxene—the latter quite subordinate to the other minerals, none of which are idiomorphic. All the above minerals contain systems of acicular needles, having very strong double refraction, with extinction angles varying from 0°—4°, and colours varying from dark brown to brownish green.

"The only other boulders found at Voorspoed and requiring special notice are roundish, highly micaceous lumps of kimberlite of the fissure variety, containing an occasional garnet. These boulders are not only round and oval in shape, but have usually very smooth and unctuous exteriors. Owing to their exact resemblance to the ground found in the fissure on which the mine occurs, it seems quite probable that they represent masses or fragments of the fissure rock which were broken up, rounded, and distributed throughout the mine when the pipe burst through. It is quite reasonable to expect the fissure kimberlite to be represented in the pipe breccia as well as the other wall rocks found therein, but some local segregationists prefer to attribute their origin to magmatic segregation. The true origin of these boulders, however, like the eclogites and altered rocks, has yet to be solved.

"The megascopic minerals found in the Voorspoed kimberlite are not very numerous or plentiful, nor do they form a 'pretty deposit' such as one sees at Jagersfontein, Koffyfontein, Bultfontein, and many other mines. The principal mineral is garnet, most commonly a clouded red in colour, and much cracked. Some transparent pink to red pyropes occur, however, and also pale yellow to orange-red bessonite. Stones of the latter quality are, however, much scarcer than the diamond both in this and every other known mine. The garnets seldom exceed half an inch in diameter. Minute octahedral crystals of picotite (chrome spinel) are plentiful. A little ilmenite occurs, and is often to be seen in dull grey very smooth grains, as if water warn. In addition to the foregoing, of

which the concentrates mainly consist, one finds a little diopside, pyrite (in both cubical and 'buck-shot' forms), calcite, mica, barite, and an occasional piece of galena. Enstatite, which is present in most of the mines and quite plentiful in some, was not observed, but might make its appearance at lower levels. The present working faces in the mines are all above the 100 feet level.

"The diamonds are of a small average size, parcels usually containing a high percentage of specimens averaging one-eighth and three carats, but stones of from thirty to forty carats in weight are occasionally found. Although 'bright stuff' of very good quality is constantly found, the grade in large parcels is not high, like Jagersfontein, Koffyfontein, and the Roberts-Victor mines. All shades of 'white' are found, and occasionally good 'blue-whites.' When cut, the white stones are very brilliant. Pale 'yellows' and 'bye-waters' are plentiful, but 'deep yellows' of the 'fancy' descriptions rare. Pale 'rose pinks' occur, but generally weigh a quarter of a carat or under, as at Bultfontein, although one of five carats was found, and retained its colour after cutting. The crystallisation of the gems is mainly of the round and elongated rhombic dodecahedron shapes, these being often very bright and smooth, and having curved faces. Perfect octahedra are seldom seen, though the Lace mine, a few miles away, contains quite a high percentage of octahedral forms. The cube, so common in South America and rare in South Africa, has also been found in Voorspoed mine, the writer having a small one in his possession weighing under one-eighth of a carat. A careful examination of one parcel by the writer showed a rather high percentage of diamonds which had undoubtedly been broken. Some of these might, of course, have been fractured in the mining and washing operations, but broken stones were found in the earlier stages of exploitation, before either dynamite or machinery was in use.

"A most interesting feature of the mine in relation to its genesis is the distinctly variable nature of the ground in different portions of the mine. About sixty claims in the centre of the pipe consist of bright yellow ground, soft and unctuous to the touch. It is full of small mica, and contains about fifty per cent. of roundish pebbles and boulders up to one foot in diameter. The

boulders have already been referred to. This ground breaks up freely in any direction into rough roundish lumps. The remainder of the mine produces quite a different class of ground, greyish in colour, harsh to the touch, comparatively free from boulders, and with much fewer pebbles. It has a distinctly laminated habit in places, and when broken up for hand specimens gives flattish lumps. The difference between the two classes of ground is so marked that one might easily conceive them to belong to independent mines. The cause may be due :—(*a*) to a secondary eruption of kimberlite in the central portion of the mine, or (*b*) to a more prolonged volcanic movement in the latter part than was experienced by the remaining and larger portion of the pipe. The first condition might enlarge the neck at depth, thereby providing a new and more abundant supply of wall rocks than had hitherto existed; whilst the second could largely augment the quantity brought up during the initial stages of eruption, and at the same time produce the more rounded and smooth forms so noticeable in the small central area."

The output of diamonds from the Voorspoed mine has been as follows :—

		Loads		Carats
1906 ...	July to December	40,096	...	9,244
1907 ...	January to June	70,311	...	13,839
1907 ...	July to December	123,041	...	26,813
1908 ...	January to June	141,346	...	28,719
		374,794		78,615

The Kimberley group has been well-described by Gardner-Williams from the mining point of view, and by Toit from the geological. It includes six important mines, namely, the Wesselton, the Bultfontein, the Dutoitspan, the De Beers, the Kimberley and the Kamfersdam, and several small pipes. The relative positions of those that are known are shown in Figure 13. Several other occurrences of kimberlite were known in the early days, but the ground on which they occur has been either built over or reserved, and almost all knowledge of their positions lost.

Of the six mines the most important are the Kimberley and De Beers, which have been opened up to a greater depth than any other diamond mine. At the end of 1907 blue-ground was being extracted at the 2,500 feet and 2,100 feet levels. They have a surface area of 470 and 620 claims respectively, and a present yield of about 35 carats per hundred loads of 16 cubic feet.

The usual inclusions of gabbrodiorite, sandstone and shale, occur in all the mines, as also do peridotite and garnet-peridotite boulders, in places predominating over the kimberlite matrix. Garnet-pyroxenites are not so common.

In the Wesselton mine a block of sandstone containing remains of a fossil fish (Acrolepis) was encountered at a depth of 135 feet, while a large mass of coal, over five tons in weight, was discovered at a depth of 220 feet. There can be no doubt that both the sandstone and the coal have been derived from strata which at one time extended over this area, and which have since been removed by denudation.

During 1905, the diamond yield of the mines in the Kimberley district was 2,187,700 carats, of a value of £4,111,200; in 1906, the output was 2,641,260 carats, valued at £6,600,230; while during 1907 the yield was 2,469,130 carats, of a value of £5,955,210.* The average price obtained per carat was 37.5, 50 and 48 shillings respectively.

One cannot help thinking it a great pity that the time and energy wasted in getting these useless stones is not directed into useful channels.

In the latter part of 1907 the depression in the diamond market set in. The exact extent to which it affected the Orangia mines is unknown, but can be approximately gauged from the Government return of the Transvaal output, which is mainly from the great Premier mine. From July, 1906, to June, 1907, inclusive, the production was 1,545,340 carats, valued at £2,203,510. During July to June, 1907-8, the output was 2,182,710 carats, valued at

* Since the above was written the output of the Kimberley Mines for 1908 has been declared at 1,510,470 carats, valued at £2,821.080.

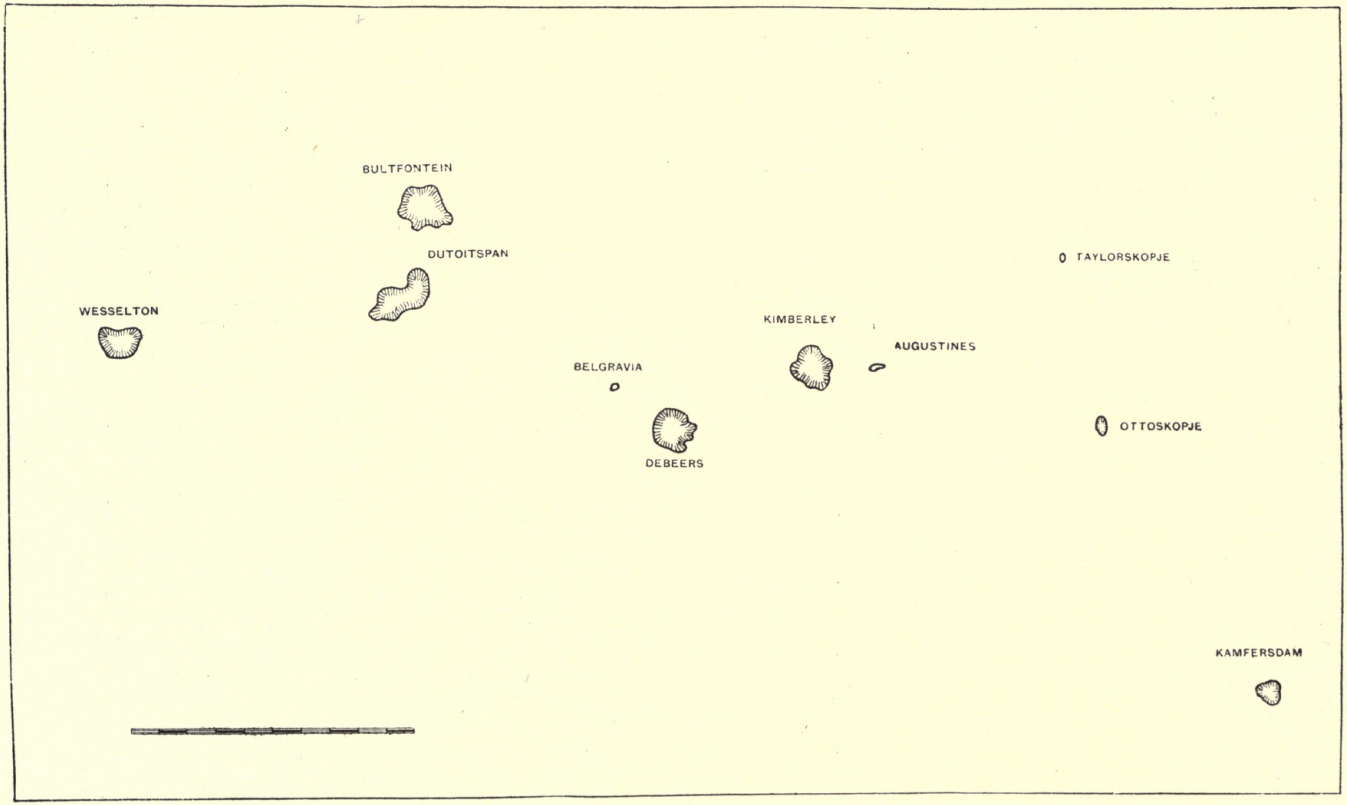


FIG. 13.—PLAN OF THE KIMBERLEY GROUP OF MINES.
Length of Scale = 10,000 feet.

£1,878,840. For the former period the price obtained per carat was 28.5 shillings, for the latter 17.2 shillings.

A large number of small pipes and dykes of kimberlite are scattered over the country surrounding Kimberley, especially between the town and the Vaal river, and in the country between the latter and its tributary the Hart, the denudation of which amply accounts for the diamonds found in the Vaal terraces or river-diggings, as they are termed locally.

The Theron and Paardeberg-East mines, previously referred to, lie about thirty miles west-south-west of Kimberley. On the farm Secretaris there is an interesting occurrence of kimberlite in fissures, which strike in different directions. The Newlands mine is situated in the valley of the Hart about ten miles from its junction with the Vaal.

Several other small pipes are known in Orangia.

CHAPTER V.

SUPERFICIAL DEPOSITS AND PANS.

Both the Orange and the Vaal are bordered by terraces of drift. In one of these, belonging to the latter river, and situated opposite the village of Barkly, a fragmentary molar of the extinct mastodon has been obtained. The country lying between these two rivers, however, is too flat to permit of the accumulation of any quantity of fluviatile drift. The rivers and spruits are merely bordered by a narrow strip of alluvium, which forms the banks, overlying a stratum of coarse detritus. Bain, the pioneer geologist, has recorded the discovery of the skull of an extinct species of buffalo, at a depth of 40 feet in the alluvium of the Modder river. The specimen is now in the Capetown museum. It had the largest horns of any known kind, the cores alone measuring 11½ feet from tip to tip. In the Bloemfontein museum there is a large horn-core from the bed of the Riet river that is probably referable to the same species.

The whole country is covered with a layer of rubbly limestone like that which is spread so widely over other parts of South Africa. It is seldom more than a few feet in thickness, and has probably originated in the evaporation of lime-bearing water, the lime being derived from the dykes.

In places, however, one meets with hard massive limestone, which breaks with a conchoidal fracture and is full of the shells of small terrestrial gastropods. It is a true travertine and must, the writer thinks, have been deposited by springs during a period of more abundant rainfall. There are no springs in those places, or, at least, none reach the surface, at the present time. Of this

period of better rainfall there is, as will be seen further on, other evidence.

Overlying the limestone is an equally widespread sheet of reddish-brown wind-borne sand. Though now overgrown with grass all the peculiar features of sand-dune topography are frequently preserved. In some places where the grass has not yet obtained complete control one can imagine oneself on the borders of the Kalahari. The writer thinks there can be little doubt but that it dates back to a time when desert conditions prevailed in this part of South Africa.

These superficial deposits are better developed in the western arid belt than in the more humid eastern belt.

That peculiar geographic feature, the pan, has long been the subject of speculation, but no generally accepted interpretation of the phenomenon has yet been forthcoming. Pans are scattered throughout the length and breadth of the country, but the western arid belt is their country *par excellence*.

The many problems connected with these pans are so bound up with the geological structure and meteorological conditions of the country that a consideration of these factors is necessary to a proper understanding of them. The whole of the western arid belt is underlain by practically horizontal bluish-black shales, which change near the surface into a tough yellowish-brown clay. Both shale and clay have the peculiar property of completely breaking up into small pieces on exposure to the sun.

The shales are intersected by numerous fine-grained gabbrodiorite dykes. On account of their superiority to the shales, in point of hardness, the larger dykes often form lines of bult or even kopjes or randjes, but the smaller and more numerous dykes seldom seem to have any direct influence on the topography, being frequently encountered in cuttings in most unexpected places.

Except on the top of the few kopjes and randjes, and in the bottom of pans, the whole district is covered with the superficial limestone and sand already referred to.

The maps of the western arid belt, issued by the Surveyor-General, well illustrate the extraordinary number of the pans, but, unfortunately, these last are only sketched in, and although their

relative positions are fairly accurately shown, the absence of correct outlines has hidden many interesting features and relationships. On the diagram on page 24 (Figure 9) of a survey which the writer made of five farms in the neighbourhood of the Roberts-Victor diamond mine, he has shown in accurate detail all the more important pans, but, as may be inferred from his more detailed contour plan (Figure 14) of the mining area, there are hundreds of smaller ones. In fact, they vary from a few feet to several thousand in major diameter. Most of the former are mere patches of mud, which never retain more than a film of water on their pitted surfaces, and that only directly after rain. The latter are usually sunk deeply below the general level of the immediately surrounding ground, and are capable of holding large quantities of water. The rainfall, however, within the memory of the oldest inhabitants, has only on rare occasions been sufficient to fill them to a depth of even two or three feet, and this quantity is absorbed and evaporated in a few months. During the period the writer spent in the neighbourhood of Boshof he never saw any water in the pans for more than a few days at a time.

Pans differ from ponds or lakes in having flat and level bottoms, there being no gradual slope to a central point or points. They are mostly egg-shaped in outline, this being the primary form. Circular pans are due to the coalescence of two ordinary pans side-by-side, while dumb-bell shaped pans are the result of the joining together of two end to end. The very large pans are mostly irregular in outline, but an accurate plan will usually reveal their elements. The bottoms of the pans are covered with a thin layer of black silt, containing a residuum of salt. This silt consists of a mixture of the prevalent clay with a little lime and sand.

Pans are not confined to Orangia, but it is noteworthy that they are practically limited to those semi-arid portions of South Africa that are made up of the horizontal Karoo beds.

Take the case first of the incipient pans or, as they would be more correctly termed, vleis, such as those shown on the contour plan. The limestone is there patchy while the sand is unevenly distributed, as one would expect it to be from its inferred origin, so that the shale has been left bare in places. Now this particular

FIG. 14—CONTOUR PLAN, BY THE AUTHOR, OF THE GROUND BELONGING TO THE ROBERTS-VICTOR MINE, ILLUSTRATING THE TOPOGRAPHY OF THE BOSHOF DISTRICT.

Contour lines two feet apart.

shale, as has been previously noted, has the peculiar property of completely breaking up into very small fragments on exposure to the sun. Water which soaks through the sand and limestone is in part retained for a little while on the shale, forming a vlei, and some animal passing over it completes the comminution of a small portion. This, on drying, is removed by the wind, and so the vlei is deepened and a pan started. But the growth of pans dependent on so fortuitous an occurrence must be very slow, and certainly could not attain to the size of the pans proper shown on the farm diagram.

A careful inspection of the contour plan will reveal many points of interest. The pan in which the mine is situated no doubt owes its origin to the fact that the diamond-bearing rock is more friable than the surrounding shale. The small and deeply sunk pan rests on a gabbrodiorite dyke.

Turning now to the big pans there are two features which immediately arrest one's attention. Firstly, they are all bounded on one or the other side by, and often occur in strings along the margin of, a large dyke ; and secondly, the farmer's wells are always situated on the edge of the pans and at their junction with the dyke.

The reason for the position of the wells is that the dykes dam back the water which soaks into the ground after rain, and the broken condition of the shale at the contact permits of a comparatively large accumulation there. It is there and there only that water is obtainable. It is recognised by the farmers, who have either learnt it from long experience or maybe acquired the knowledge from the aborigines they displaced. A well sunk along one of the dykes draws on a considerable length of the dyke, though not on the entire length, for there are many cross dykes, and so with the ordinary demands made on it by the present farmers, the level of the water is not appreciably lowered during the dry season.

The water in these wells usually rises to within a few feet of, and in some cases actually reaches, the surface. With a greater rainfall it would burst out as springs.

The writer has already cited evidence to show that at no distant epoch the country enjoyed a better rainfall. Towards the end, at least, of that time, it was populated by a people of the Stone Age. It is safe to say that wherever there is a well where the water at the

present day reaches the surface, there will be found the débris of the settlements of that people. Now the remains of these settlements are to be found also round shallow water-holes in which water is no longer found, and also at places where there is not even a hole. But always at the edge of the dyke, where we know water exists at a slight depth, and where it formerly reached the surface. That such springs really existed there can be no doubt, for the inhabitants had to have water and then, as now, there was no other source.

These settlements seem to have been established after the pans had been formed, but before the incoming of desert conditions. Quite sharp and fresh-looking stone implements and other relics are sometimes found resting on the bottoms of the pans, preserved under a covering of rainwash, while the adjacent rubbish-heaps, containing identical objects, are often concealed under a covering of the sand. Maybe the aborigines never occupied all the springs at one time, but merely wandered from one to the other.

Looking back to the still earlier time when the pans were in the stage represented by the vleis we have already considered, we are now at once able to divine the secret of their great growth. Those vleis only hold water for a brief hour or two after rain, but these possessed more or less permanent spring-fed pools, to which the vast herds of game would repair to slake their thirst. The atmospherically disintegrated shale would be completely pulverised by the tramping of the animals, and the wind would rapidly remove it. Alison, in an early volume of the " Transactions " of the Geological Society of South Africa, has drawn attention to the rôle played by animals in the excavation of pans, but has, the writer thinks, attached too much importance to it.

That animals walking into a muddy pool must carry away and deposit elsewhere a certain amount of the mud is obvious, but whether large pans could be formed in that way is extremely doubtful. A more vigorous transporting agent would seem necessary, and there we have it in the shape of the wind. The process can still be seen in operation, though much relaxed, because now the wind is the only potent factor, and that alone is not sufficient.

To sum up, it would appear that at no very distant epoch the country possessed a better rainfall. At that time man may or may

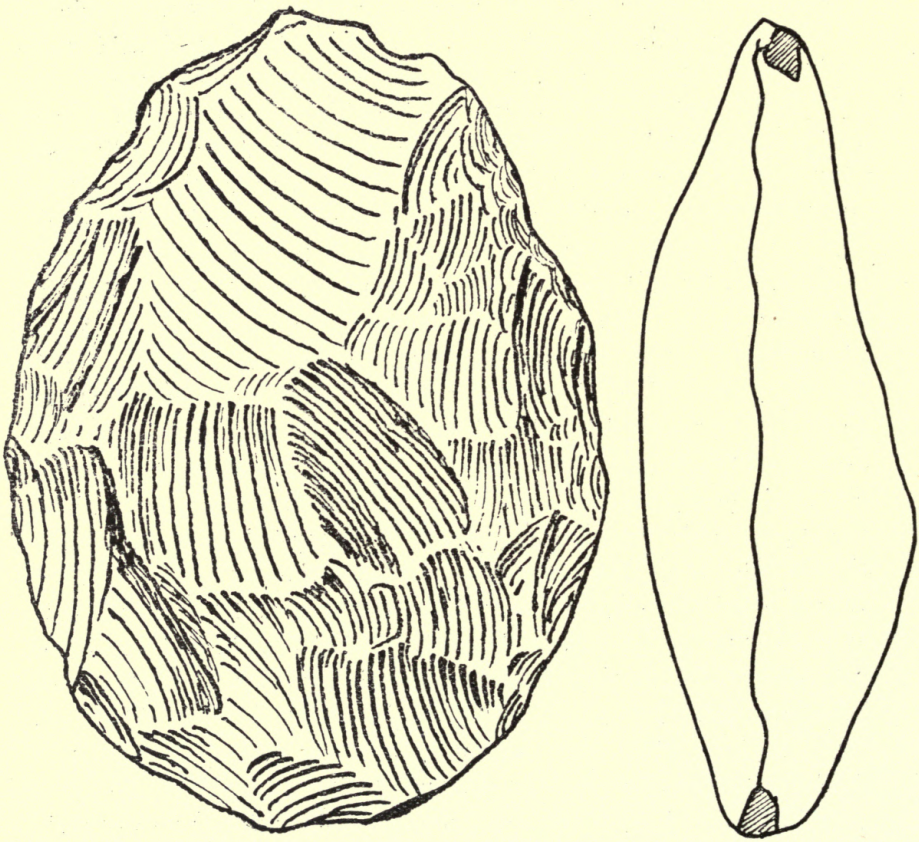


FIG. 15.—ACHEULIC AMYGDALITH FROM LUCKHOFF. (*Actual size.*)

not have penetrated so far south. Then the rainfall gradually decreased and arid conditions set in. Pans were formed and rapidly increased in size. Numerous settlements were established around the springs at the edge of the pans by a people who were in the Solutric stage of culture. Later the rainfall still further decreased. Most of the springs failed, and the pans ceased to grow, the climate being much the same as it is now. Eventually desert conditions set in to be finally replaced by the little better conditions of the present day.

The small pans may have originated in several ways. The large pans owe their origin to springs, and their growth partly to the herds of animals which frequented them, and partly to the action of the wind.

The formation of pans by these factors, however, was only rendered possible by the flatness (itself a result of the geological structure) and aridity of the country.

The silt in many of the larger pans contains a sufficiently high percentage of salt to repay extraction.

Thermal springs are widely distributed in Orangia. In putting down a borehole in the Roberts-Victor diamond mine one was tapped at a depth of 630 feet ; it rose with a pressure of 15 lbs. to the square inch, and had a temperature of 25 degrees C.

CHAPTER VI.

THE PRE-HISTORIC PERIOD.

Our knowledge of the pre-historic period of South Africa, like that of other parts of the world, is mainly derived from the almost imperishable stone implements which were then used, and which remain when all other objects have gone. Two very distinct groups of stone implements are found in Orangia, namely, the Acheulic and the Solutric. Their relationship in point of age, however, has hitherto been uncertain.

While the Acheulic implements are almost exclusively amygdaliths, the Solutric ones are nearly all flake-tools. They are thus probably complementary to one another, which circumstance suggests that they may be contemporary. To this interpretation, however, there are the following objections :—(1) In the few cases where an Acheulic amygdalith has been found together with a series of Solutric flake-tools, it has always been much more weathered and worn; (2) in the few cases where an undoubtedly contemporary amygdalith has been found with the Solutric flake tools it has always been far superior in shape and workmanship to the Acheulic amygdaliths. These facts point to the Acheulic implements being older than the Solutric ones, though they are too few to be conclusive. It should be noted in this connection, too, that flakes of an unquestionably earlier period occur on the Solutric sites at Petrusburg and Rietkuil.

The term amygdalith, it should be explained, is a new one, intended to designate the class to which the typical Acheulic implements belong.

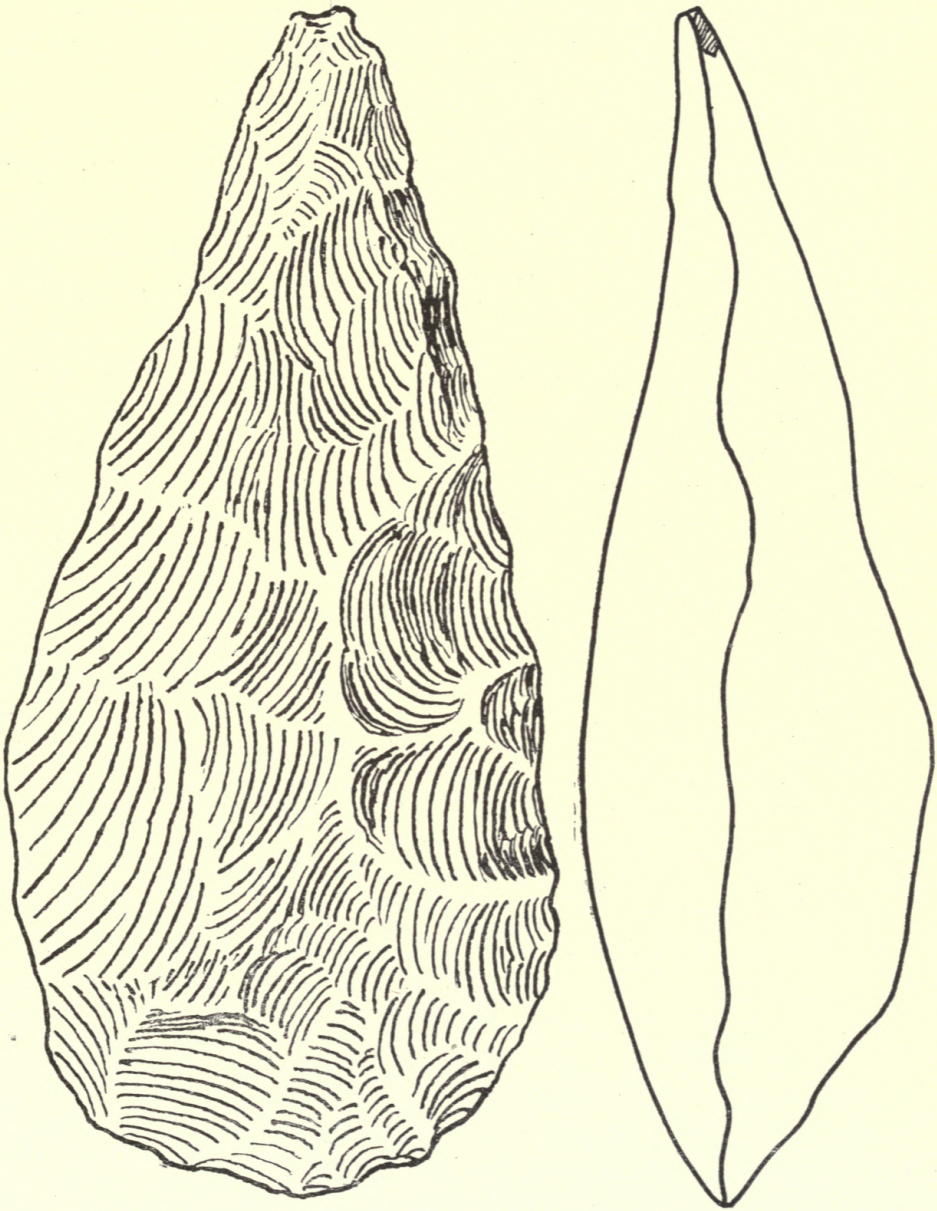


FIG. 16.—ACHEULIC AMYGDALITH FROM LUCKHOFF. (*Actual size.*)

More convincing is the evidence afforded by the Acheulic site at the village of Luckhoff which, in the writer's estimation, undoubtedly demonstrates a great difference in age between the two groups. At this site the Acheulic implements occur under identically the same conditions, and are mostly made of the same material, as those of the Solutric sites near Boshof and at Petrusburg. That is, they are both mingled with débris accumulated—in the former case naturally, and in the latter artificially—on the solid rock underlying the layer of red sand. Yet the one group is deeply weathered and worn while the other has barely suffered a change of tint.

The Luckhoff implements were exposed in the gullies and on the slopes leading down to the dam, where the covering of sand had been removed by the rain. They were associated with numerous flakes and chips, which were probably produced in their manufacture. They comprise two kinds, namely, amygdaliths and axe-heads.

The amygdaliths were by far the most abundant. They consist of pieces of stone chipped to a more or less flat shape, with the length, as a rule, greater than the breadth, and an edge worked along a portion or the whole of the periphery. Most are almond-shaped, and range from a symmetrically oval disc to a disc with one end drawn out to a long point, a form intermediate between the two being commonest. They are made out of lydian-stone, rounded pieces of which are abundantly met with throughout the whole of western Orangia, and are much worn and deeply weathered, the facets being nearly obliterated and the outside changed to a reddish-brown colour. This lydian-stone much resembles flint in its appearance and in its fracture, but while equally sharp when fresh, is softer, and hence weathers much more rapidly. The average length of these implements is about eleven centimetres.

The axe-heads, of which there are only seven, are manufactured from the local fine-grained gabbrodiorite, and are also much weathered and worn. They are much larger than the amygdaliths, which accounts for the material used, because, while less easy to work, owing to its toughness and uneven fracture, it is readily obtained in larger pieces than is the lydian-stone.

I have noted elsewhere the occurrence of large characteristic Acheulic flakes, as well as unfinished amygdaliths, among the débris on the sides of the hills south of the village of Douglas.

The junction of the Riet and Modder rivers has been rendered classical by Rickard's account of his discovery of Acheulic implements there.

"The implements from the Junction were found in the bed of the river immediately below the point where the rivers become confluent, lying either on the bare rock or in small hollows containing a little coarse gravel; I collected upwards of eighty specimens in a few hours, but had to abandon the majority of them on account of the difficulty and cost of transport."

He devotes two plates to them. Plate I. shows two typical amygdaliths. Plate II. shows a fine axe-head drawn to actual size.

I myself obtained quite a number of both types there, but they are all very much waterworn, being practically reduced to pebbles. I have no doubt that they come from the gravelly stratum at the base of the alluvium. This was east of the bridge.

West of the bridge, and some little distance north of the river, I found a great quantity of quite fresh and sharp flake-tools of lydian-stone, mixed with flakes and cores. They had been exposed to view by the removal of a thin covering of surface soil.

Nineteen examples are figured in the 1906 *Report of the South African Association for the Advancement of Science*. They are a similar assemblage to that illustrated from near Boshof and other localities in the next chapter, and bear a close resemblance to the Solutric implements of Europe. Interesting are the extremely elongate kinds, and the variety trimmed at both ends. These implements are unquestionably newer than the alluvium.

Together with them I found three or four chert flake-tools, a multiple-grooved cylindrical piece of sandstone, a hemispherical stone with a hole bored to a depth of about one and a half centimetres from the flat side, numerous ostrich-egg shell fragments, a bead made of same, and the half of a glass bead. This last has probably no connexion with the other objects.

I have three typical Acheulic amygdaliths from near Boshof, one each from the Schaapfontein-Dieplaagte and Elandsput pans,

and one from Meerlandsvlei. They are made of lydian-stone, and are much worn and deeply weathered, the facets being nearly obliterated and the outside much changed in colour. Their ancient appearance, viewed in the light of the data already given, leads me to conclude that they are much older than the Solutric groups to be described from there in the next chapter. With them also belong the neat little amygdalith from Damplaats represented by Figure 17.

The Taaibosch spruit is a tributary of the Vaal, and flows into that river south-west of Vereeniging. Mrs. Hutt had previously

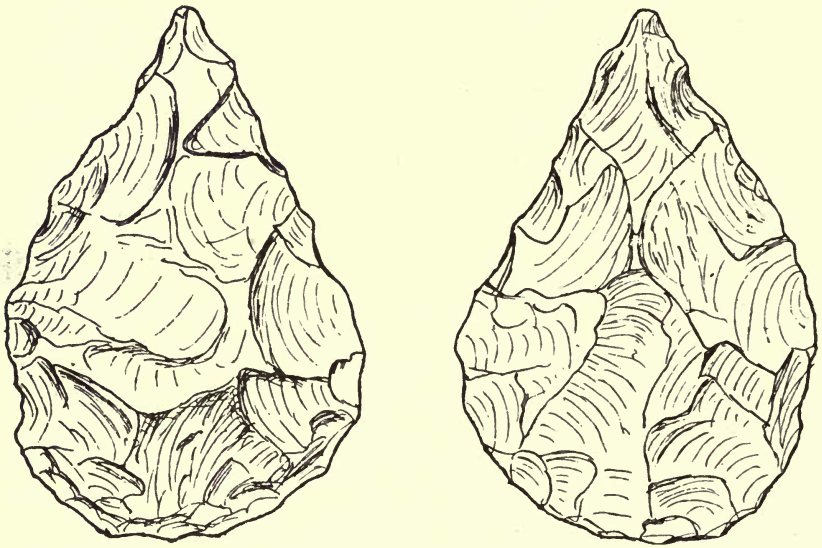


FIG. 17.—SMALL ACHEULIC AMYGDALITH FROM DAMPLAATS.
(*Actual size.*)

obtained Acheulic implements there, and drew my attention to the fact.

As in the case of all the large spruits in this part of South Africa, this one is bordered by a varying thickness of fine alluvium, at the base of which is a stratum of coarse detritus.

The more important finds comprise a group of implements of Acheulic type from beneath, and a group of implements of Solutric type from above, the alluvium.

From the bed at the base of the alluvium I have obtained, in

addition to a quantity of the characteristic large flakes, a number of typical Acheulic amygdaliths. They are fashioned out of a green aphanite, and are all waterworn, some being reduced to the condition of a pebble. One of the specimens is as much as 22 centimetres in length, whilst another is only 9. I also found examples of the group of large flakes worked on one side and edge only. No axe-heads were obtained.

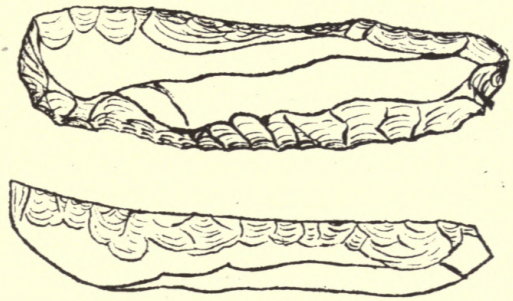


FIG. 18.—A TYPICAL UNWEATHERED SOLUTRIC FLAKE-TOOL FOUND WITH THE DEEPLY WEATHERED ACHEULIC AMYGDALITHS AT LUCKHOFF, AND FASHIONED OUT OF THE SAME LYDIAN-STONE.
(*Actual size.*)

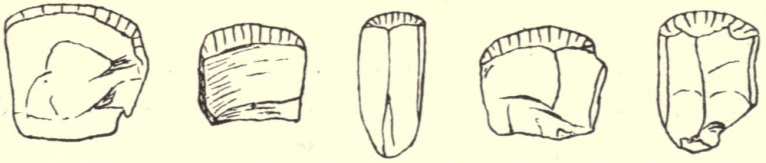


FIG. 19.—TYPICAL SOLUTRIC FLAKE-TOOLS OF CHERT FROM THE TAAIBOSCH SPRUIT. (*Actual size.*)

In places on top of the overlying alluvium, I came across quantities of very small flakes of chert, jasper, and agate, and here and there among them, examples which had been trimmed into minute flake-tools. Some of these are shown in Figure 19. It is difficult to imagine exactly what could have come within the scope of these remarkably small tools. The fineness of the secondary trimming is really wonderful.

They are of the same class as, and contemporary with, those from the Junction of the Riet and Modder rivers. The difference in facies is due to the fact that in some localities the only available material was the lydian-stone, and at others the three varieties of flint. Now the lydian-stone occurs in comparatively large pieces, and permits of the manufacture of comparatively large flake-tools, while at the same time affording scope for the wide range of variation exhibited. The chert, jasper, and agate, on the other hand, are only accessible as small pebbles, and therefore small flake-tools were the rule, and variation was correspondingly restricted. These siliceous pebbles are derived from the amygdales of the lavas of the Ventersdorp and Karoo systems.

The water-hole on the east side of the village of Petrusburg was evidently the centre of a Solutric settlement. On the heaps of soil which had been dug up in enlarging it, I found a number of the characteristic lydian-stone flake-tools. They are nearly all of the thick wedge-shaped type (see Figure 23), including its long and short derivatives. I also obtained a fine chert example of the latter variety.

Together with these comparatively fresh and unworn implements, and contrasting strongly with them, were a few much worn, and more deeply discoloured, flake-tools of the same material, and no doubt contemporary with the Acheulic amygdaliths previously described.

It may, of course, be argued that the above evidence only proves that *some* Acheulic implements are older than *some* Solutric ones.

CHAPTER VII.

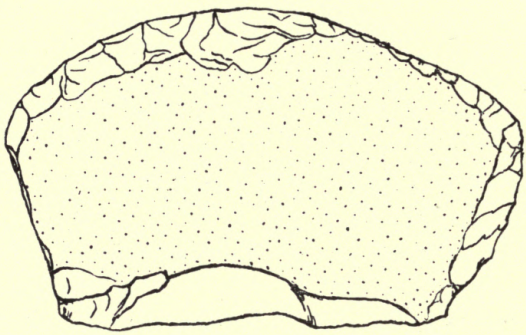
SOLUTRIC SITES.

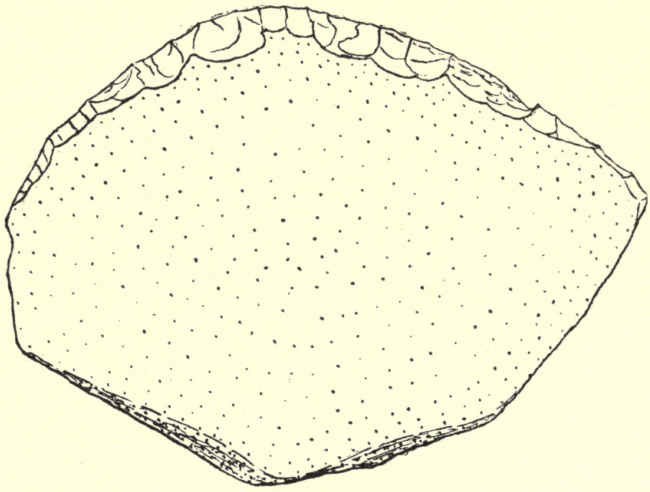
The implements of the newer group from near Boshof are a similar assemblage to that from the Junction of the Riet and Modder rivers, and are mostly made of the same lydian-stone. They occur in great quantity on the sites of prehistoric settlements. These settlements were all situated around springs, which in many cases no longer reach the surface. The implements are mostly flake-tools (scrapers), and, as one might expect from their occurrence, are as sharp as on the day they were made, though as a rule they have changed externally from their original black colour to various shades of grey.

Most of the sites are shown on the plan reproduced in Figure 9.

The Rietkuil site is perhaps the most interesting. There is a spring there which must have once been the centre of a large settlement. All around are extensive middens, which are now hidden from sight by a covering of sand, but whose presence is plainly shown by the little mounds of débris turned up by burrowing animals. Judging from the numerous finds in the very limited amount of material accessible, they would well reward a systematic exploration. Every little heap of ash contains quite sharp and fresh flakes and cores, mixed with pieces of bone and fragments of ostrich egg-shells, while finely finished flake-tools are not uncommon. Most of the flakes are slightly trimmed, the secondary chipping in many cases being, I think, the result of use; though in other instances due to the intentional removal of inconvenient projections along the edge. It is noteworthy that some of the flakes

A





B

FIG. 20.—FLAKE-TOOLS, FROM ELANDSPUT AND SCHAAP-FONTEIN-DIEPLAAGTE. (*Actual size.*)

have been struck off older large weathered flakes. Small chert and jasper flakes were also found, as well as a few neat little flake-tools of that material.

The peculiar wedge-shaped flake-tools shown in Figure 23 are the dominant form at that site. Some are only half as long as these, though just as broad and thick.

I also obtained hammer and grindstones, a multiple-grooved cylindrical piece of sandstone, the half of a single-grooved tabular piece of aphanite, portion of a stone ring (armlet?), and flat pieces of the local gabbrodiorite polished on one side by use. Besides these I found the greater part of a bone pin, an ostrich egg-shell bead, and the incised fragment of ostrich egg-shell shown in the top left-hand corner of Figure 24. I also picked up a piece of the shell of a large pelecypod (Unio?). Fragments of a plain hand-made pottery are abundant, while I obtained one decorated piece, the decoration—which is not complete—consisting of four rows of cord pattern.

It is interesting to observe that the farm cemetery is situated on part of the area covered by the middens, while the present-day rubbish heap is being piled up close by, both of which circumstances afford a much needed warning against always lumping together everything found on one site.

The Tweelingsfontein site is situated near a spring also. A shallow well had been sunk on this at some time or other, and the excavated clay and shale thrown up in a heap all round. In enlarging this well a cavity was met with in the made ground resting on the undisturbed clay (weathered shale) which occurred at a depth of 5 feet. In this cavity were found three ostrich egg-shells. Two of them were broken, but the remaining one, which I secured, was fairly intact, a small piece only having been knocked off by the point of a pick. The end was perforated to allow of its being used as a water-bottle, and the cuts round the opening have the appearance of being made with a stone flake. Immediately on hearing of the discovery, I visited the spot, but the ground round the cavity had been removed, and the remains of the other egg-shells dispersed. There was a certain amount of ash among the excavated débris, as well as part of the skull and some broken bones of the ox. I also obtained a grindstone, the half of one of the well-known per-

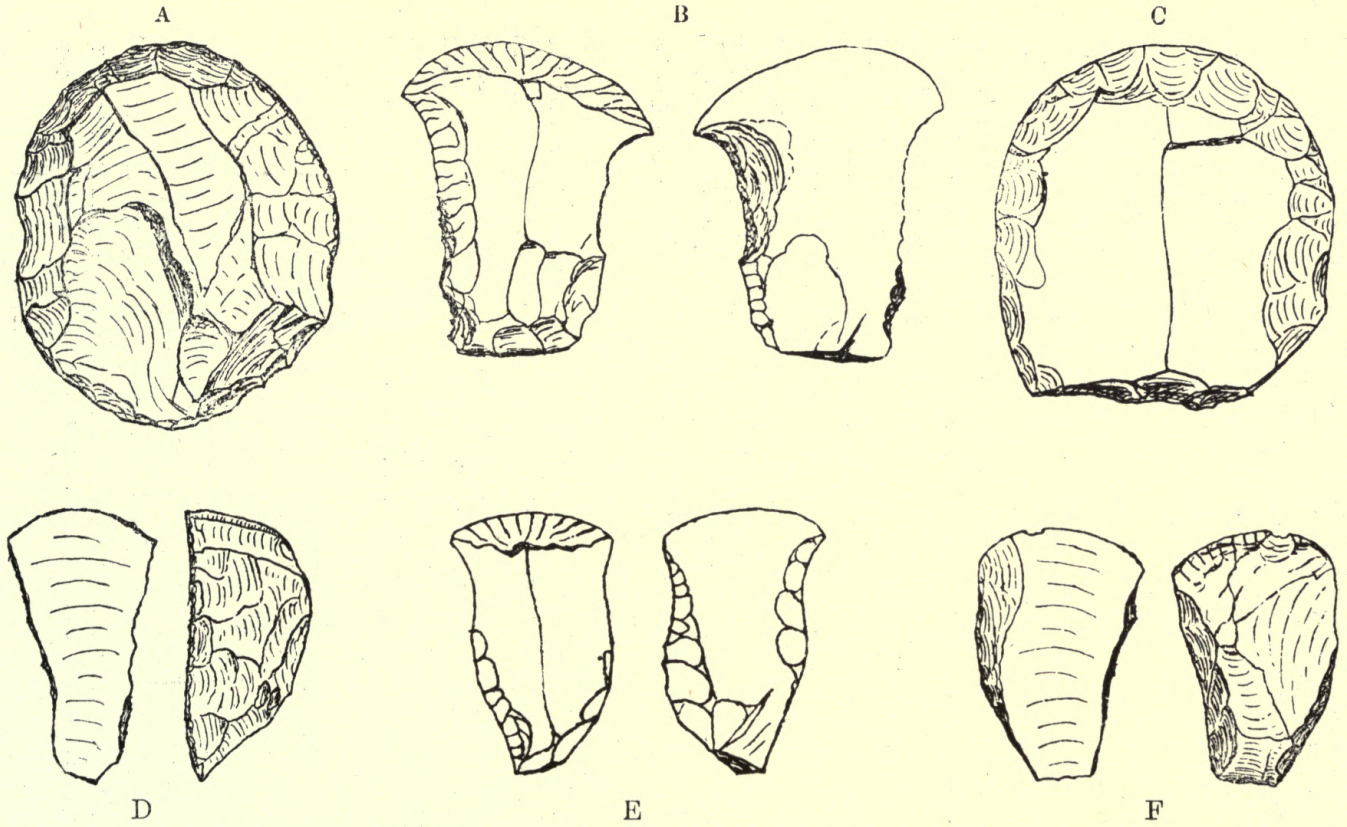


FIG. 21.—FLAKE-TOOLS FROM (A) TWEELINGSFONTEIN; (B) DAMPLAATS; (C) RIETPAN; (D AND F) RIETKUIL AND (E) KALKGAT. (*Actual size.*)

forated stone balls, and a single-grooved tabular piece of aphanite like that from Rietkuil.

This spring is situated on the edge of a very large pan, not shown on the plan. Close by, the thin covering of silt in the bottom of the pan has been scraped up to form a dam wall. There, numerous flakes, cores, and finished flake-tools have been exposed to view. Together with them I found a neat little lanceolate amygdalith of typical Solutric form, worked on both sides.

On the south side of the west end of the pan by the Damplaats farmhouse, where the bottom had been stripped of silt, I came across a fine series of the flake-tools of this group. Some of them are really remarkable for their fine workmanship. There, long T-shape flake-tools are dominant.

There must once have been a spring there, though there is no trace of one now.

There is the débris of a settlement round the now dried-up spring on the edge of the Elandsput pan, from which I have obtained a number of implements and other relics. The thin flake-tools, trimmed at the end only, are there more conspicuous than at the other sites, but thick forms are still in the majority. One or two of the flake-tools are remarkably minute.

In digging up one of the ash heaps, I came across a slab of the local gabbrodiorite, in which a hollow had been ground, together with the actual grindstone which was used with it.

I have also one of the well-known perforated stone balls, which was picked up in the pan and given me by my friend, Mr. Develing.

Still more interesting are a number of fragments of incised ostrich egg-shell—presumably the remains of water-bottles—from here. Some of these are shown in Figure 24. The specimen in the top left-hand corner is from Rietkuil, and the large middle specimen is from the Lange Berg, the rest being from Elandsput. The perforated piece of egg-shell—the initial stage in the manufacture of a bead—is from Elandsput also.

I also found a number of completed egg-shell beads, also portion of a cowrie. This last is noteworthy, as it is a marine shell, and must have been brought up from the coast.

I have two large perforated stone balls from Vooruitzicht and

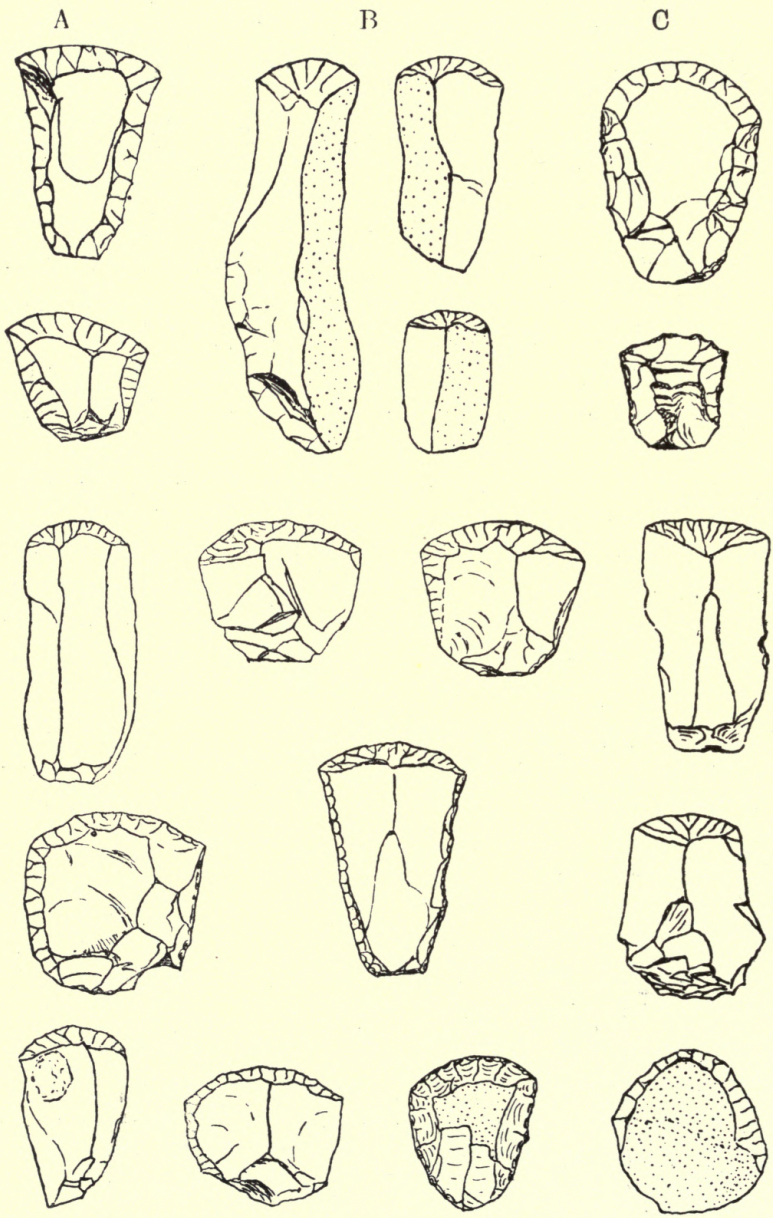


FIG. 22.—FLAKE-TOOLS FROM RIETPAN AND (A) RIETKUIL, (B) ELANDSPUT, AND (C) DEVILLIERSRUST. (*Actual size.*)

a small one from Meerlandsvlei, which were given me by Mr. Jones. They well illustrate the diversity in size and weight of these curious objects. The largest specimen measures 10 centimetres along the perforation, and weighs about 4½ lbs., while the smallest is only 4 centimetres in diameter, with a weight of about ¼ lb. The latter is not completed, the hole, which has been started from both sides, not being finished. There are traces of middens round the well on Vooruitzicht, and I obtained a characteristic flake-tool and some pieces of pottery there.

I have a few of the characteristic flake-tools of this group from the farm Schaapfontein-Dieplaagte, and there are traces of middens in places on the west side of the pan. At the point marked thus (*)

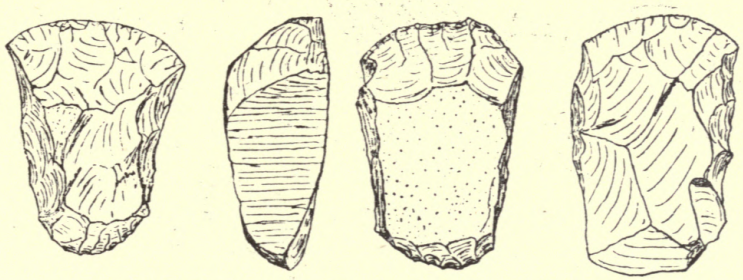


FIG. 23.—FLAKE-TOOLS FROM RIETKUIL. (*Actual size.*)

there is a prominent outcrop of the local fine-grained gabbrodiorite, in which several small hollows have been worn by grinding.

On the farm Rietpan I obtained a large number of flake-tools from beneath a thin layer of rainwash, situated by the edge of the pan not far from the homestead. There, thick flake-tools still predominate, but thin forms are better represented than at the sites previously considered in this chapter. A series of the latter is illustrated in Figure 22. As at the other sites, some are a good deal larger than the average, while others are much smaller, one (see Figure 24) measuring 12 by 9 millimetres; but neither extreme is common. The very long flake-tools, and those trimmed at both ends, are well represented. I also obtained a very fine jasper example of the short variety of wedge-shaped flake-tool, as well as five small

chert examples of more ordinary form. While a large proportion are most exquisitely finished, a great many have been very roughly made. I also found an ostrich egg-shell bead and a piece of pottery together with the implements.

The site on the farm Devilliersrust is probably the most extensive and prolific of all that I have examined in this district. It is situated round an old spring on the edge of the pan and close by the homestead. The water no longer comes to the surface, but is reached by means of shallow wells.

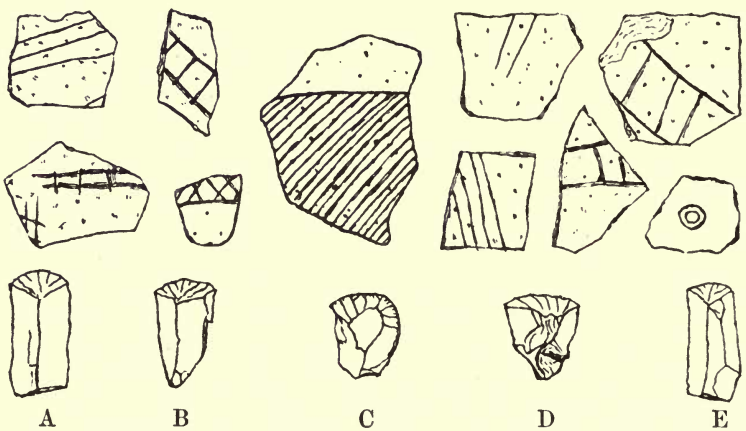


FIG. 24—INCISED FRAGMENTS OF OSTRICH EGG-SHELL AND MINUTE FLAKE-TOOLS FROM ELANDSPUT (A AND B), RIETPAN (C), KALKGAT (D), AND DEVILLIERSRUST (E). (*Actual size.*)

The middens have been well turned over by the plough, and large numbers of beautifully-finished flake-tools exposed to view. Thick specimens are rare, while the wedge and T-shaped forms are conspicuous by their absence. Some are truly minute, yet lose nothing in quality of finish on that account. Very small chert flake-tools also occurred.

I also obtained a perforated stone which differs in many respects from those previously referred to. Whereas they are either spherical or spheroidal in shape, this one is discoidal. The hole has been bored from both sides, and, instead of being of uniform size, gradually decreases in diameter till at the middle it has only half the dia-

meter it possesses at the two ends. Further, the striæ in the hole are annular, not longitudinal, showing that the motion of the implement when in use was rotary instead of reciprocal.

Fragments of a plain hand-made pottery are abundant, and I found the greater part of two bone pins (portions of arrows), a piece of ostrich egg-shell with a hole bored in it, five completed egg-shell beads, and a circular piece of ostrich egg-shell.

During a hasty visit to the farm Kalkgat, I obtained some characteristic flake-tools from a spot on the edge of the pan by the homestead. They include an example of the wedge-shaped type. One scraper well illustrates the not very common feature of being notched on the sides to facilitate attachment to a handle. A few of the specimens are remarkably neat and small. Most important is a chert example of the crescent variety of "pigmy implements," a peculiar group that is more fully dealt with later.

The group of implements considered above is an extremely interesting one, but, at the same time, a very difficult one to adequately describe and illustrate—so multitudinous are the varieties, so remarkable the identity of specimen after specimen from different localities, so similar the general assemblage, and yet so distinct the local facies, that one requires to see all the specimens to appreciate them. They cannot be very ancient. The conditions under which they occur are final and conclusive on that point; but they may have some antiquity. There is evidence of a considerable change in the meteorological conditions of the country since the makers of them lived there; but such changes do not always require lengthy periods of time.

Riverton island, on the Vaal river, is famous for the outlines of animals and the curious geometric figures which are pecked on the polished rock-surfaces. The large representation of an eland mentioned by Stow is still in existence, though sadly damaged.

Above the alluvium and gravel on the south side of the river is a thin covering of constantly shifting sand. In places where this had been blown away I came across, in great abundance, a most interesting group of implements. Apart from hammer and grindstones, a perforated stone ball, and grooved cylindrical pieces of sandstone, they may be divided into three series:—(1) Flake-tools

of lydian-stone and green aphanite, resembling in a general way those from the Junction of the Riet and Modder rivers; (2) minute chert flake-tools, like those from the Taaibosch spruit; and (3) pigmy chert implements of remarkably delicate workmanship, mostly of peculiar form and unknown use.

A series of these last is shown in the accompanying illustration (Figure 25). They are a group that is already known from such distant corners of Eurasia as Britain and India. They comprise six distinct types, including the highly characteristic crescent, besides little borers that were probably employed in the manufacture of the ostrich egg-shell beads. The smallest crescent measures only 9 millimetres in length.

Among the Riet and Modder group the short variety of the wedge-shaped flake-tool is well represented. Many of the flake-

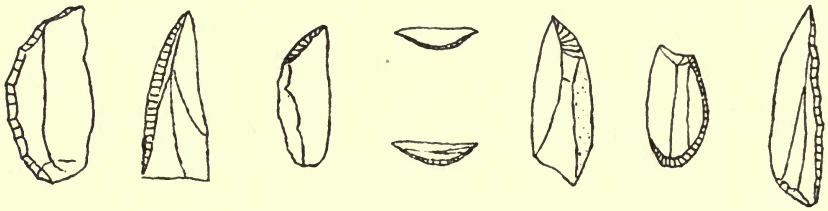


FIG. 25.—PIGMY IMPLEMENTS FROM RIVERTON. (*Actual size.*)

tools of the Taaibosch spruit group are much smaller than those from the type locality, though beautifully finished. Equally small circular flake-tools made from the half of a pebble occurred in great quantity.

Besides these I obtained fragments of pottery, and a number of ostrich egg-shell beads, as well as spherical and cylindrical glass beads. These last, though much discoloured by long exposure to the weather, probably have no connection with the implements, there being all sorts of other modern débris associated with them in places. At the present time there are a number of Kafirs living in huts on part of the old site.

An idea of the extent of the industry which once flourished on this Solutric site may be gathered from the statement that from the comparatively small area then exposed to view I obtained over thir-

teen hundred flakes, cores, unfinished and rejected implements, as well as seven hundred beautifully finished flake-tools.

In the second edition of my book on the *Stone Implements of South Africa*, I have referred to the discovery by Mr. Cottell of a similar assemblage of Solutric flake-tools to that from the Junction

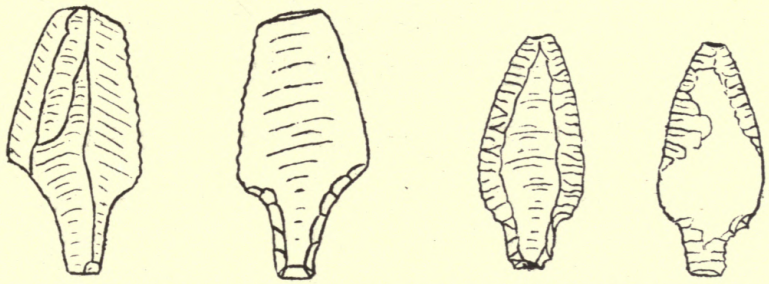


FIG. 26.—ARROW-HEADS FROM CRADOCK. (*Actual size.*)

of the Riet and Modder rivers and Boshof, near the village of Cradock. Since that was published he has found on the same site, and kindly given to me, the two arrow-heads shown in Figure 26. Though the locality is outside the area here dealt with, the discovery is sufficiently important to warrant mention.

CHAPTER VIII.

PETROGLYPHS AND ROCK-PAINTINGS.

PETROGLYPHS and rock-paintings are widely distributed over Orangia. The former are mostly found on boulder-like outcrops of rock, either among kopjes or in the open veld, while the latter are chiefly met with on the back of rock-shelters. The objects illustrated are mostly animals and men which, except in rare instances, are shown in silhouette only. The petroglyphs are usually larger than the paintings and, as a rule, represent disconnected units only, whereas the paintings frequently depict connected objects such as the participators in a hunt or fight. Many of the more advanced paintings constitute intelligible records of customs and myths.

There are some aboriginal peckings on the kopje overlooking the Kafir location attached to the village of Koffyfontein. They mainly depict various wild animals, such as the rhinoceros, eland, haartebeeste, and ostrich. I obtained several characteristic Solutric flake-tools of lydian-stone from in between the boulder-like outcrops of gabbrodiorite on which they occur.

The most numerous series of peckings that I have yet seen are on the farm Biesjesfontein, some eighteen miles south-west of Koffyfontein. They are situated on the kopje adjoining the homestead. Only wild animals are represented, the eland, which was evidently a favourite, predominating. Men are also depicted, while geometric figures are common.

Besides these are several representations of the eland, which have been *scratched* instead of pecked on the rock.

Most interesting, however, are two engravings, of which there are probably more examples. Tracings of them are reproduced in

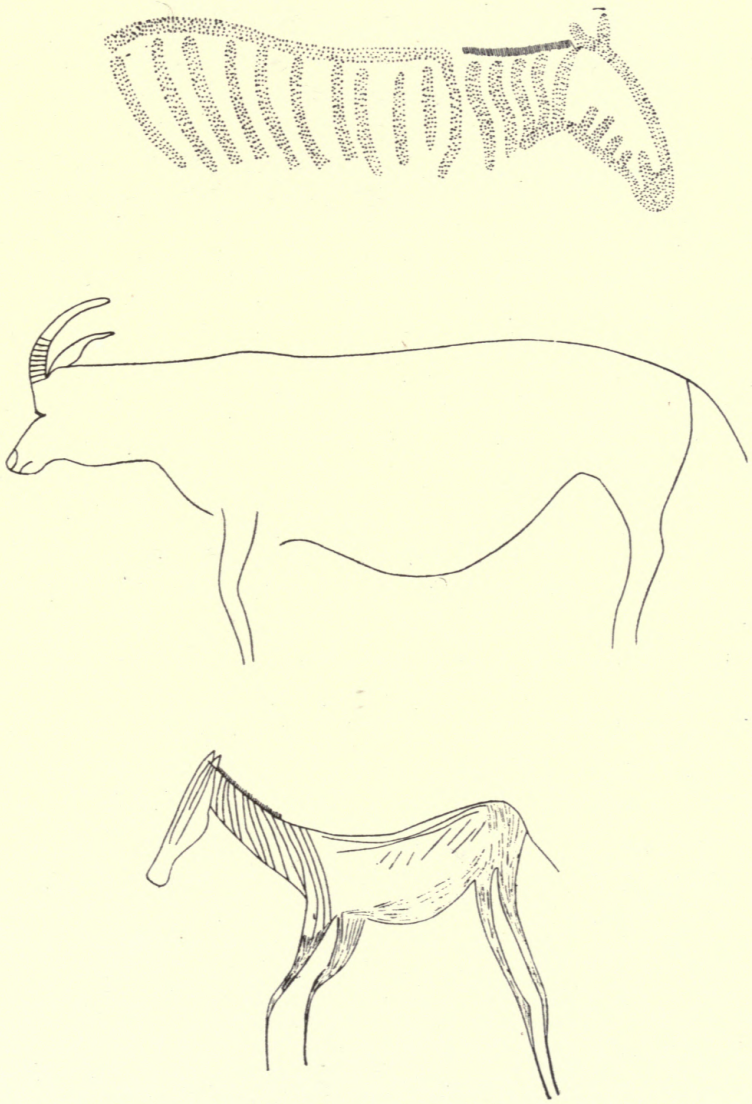


FIG. 27.—REPRESENTATION OF ZEBRA, HIPPOTRAGUS, AND QUAGGA, PECKED AND ENGRAVED ON ROCK, BIESJES-FONTEIN. (*Scale* $\frac{1}{3}$).

Figure 27. The one is a large engraving in outline of a species of hippotragus, the other is a small engraving in detail of a quagga.

The former is probably the initial stage in the production of a pecking. The latter, on the other hand, was clearly never intended to be pecked over.

These petroglyphs are all in a more or less similar state of preservation, the worked portion of the rock being mostly weathered to nearly the same colour as the original surface. It is impossible to decide whether the small range of variation in this respect is due to the unequal resistance to disintegration of the rock or to difference in age.

In addition there are three engravings of animals, representing eland, gemsbok and gnu, done in the same style as the quagga, but of markedly inferior workmanship, which are so fresh in appearance that they might very well have been made only yesterday. They are, however, undoubtedly aboriginal work, and are far superior to the engravings about to be described from Looge Kopje. The farmer, too, remembers them being there when he acquired the farm, 47 years ago. This shows that the process of weathering must be a very slow one, and that the more altered petroglyphs may be very old indeed.

Among the boulder-like outcrops of gabbrodiorite, on which the figures are depicted, I came across in places where the soil had been washed away, some characteristic lydian-stone flake-tools of the Solutric group.

The most interesting series of petroglyphs that I have yet seen are situated on the randje which runs along the eastern boundary of the farm Baviaanskranz, some 23 miles south-west of Biesjesfontein. They much resemble those of the last-named locality, but while the peckings are not so numerous, the small engravings are better represented.

The occurrence has already been noticed by Peringuey, who has figured a photograph of one of the petroglyphs. This specimen, which is now in the Bloemfontein museum, where it was sent by Mr. Parkinson, is noteworthy as being an example of an eland scratched on the rock, like those noted at Biesjesfontein. The engravings appear to have escaped notice.

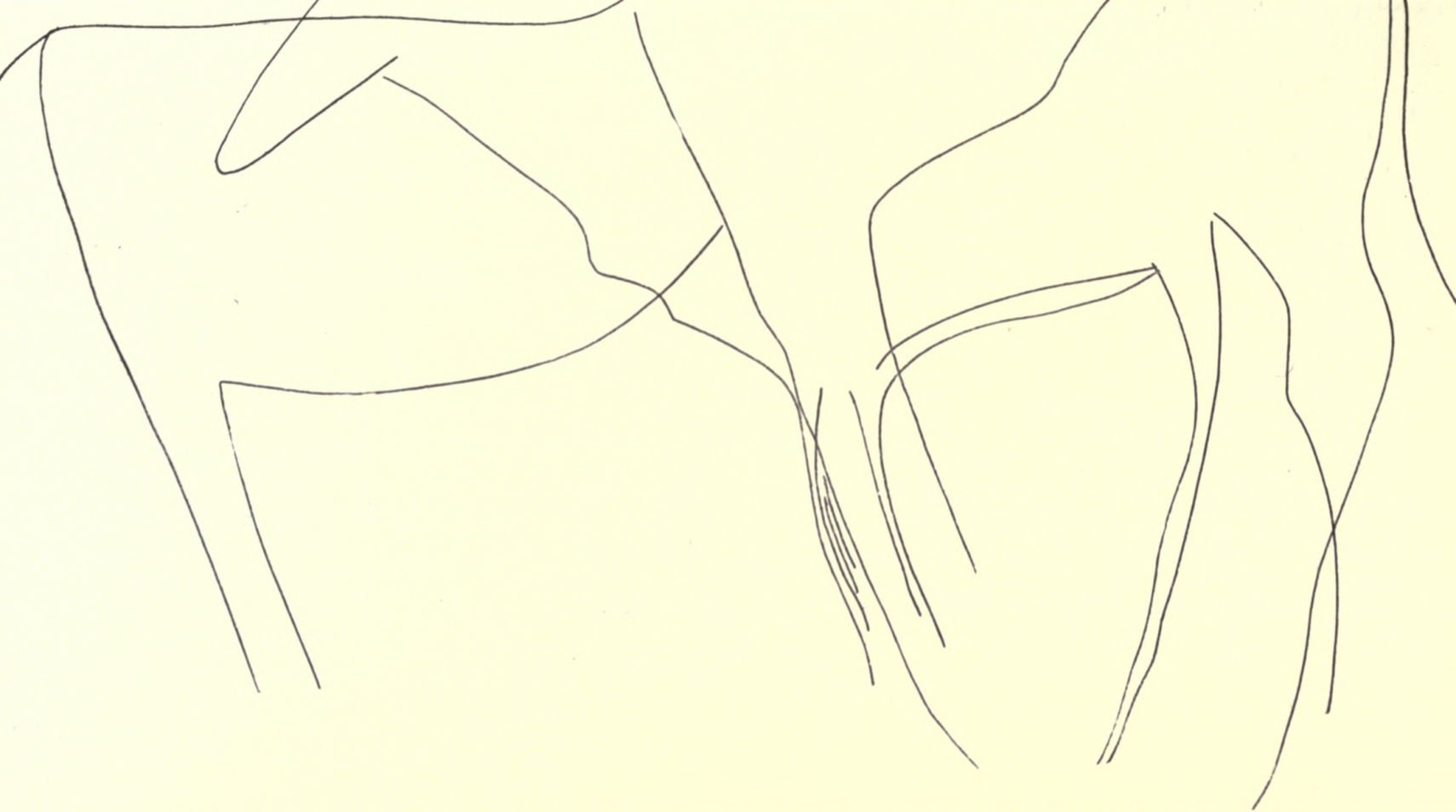


Fig. 30.—SUPERIMPOSED FIGURES OF ELAND, ENGRAVED ON ROCK, BAVIAANSKRANZ. (*Scale* ½.)

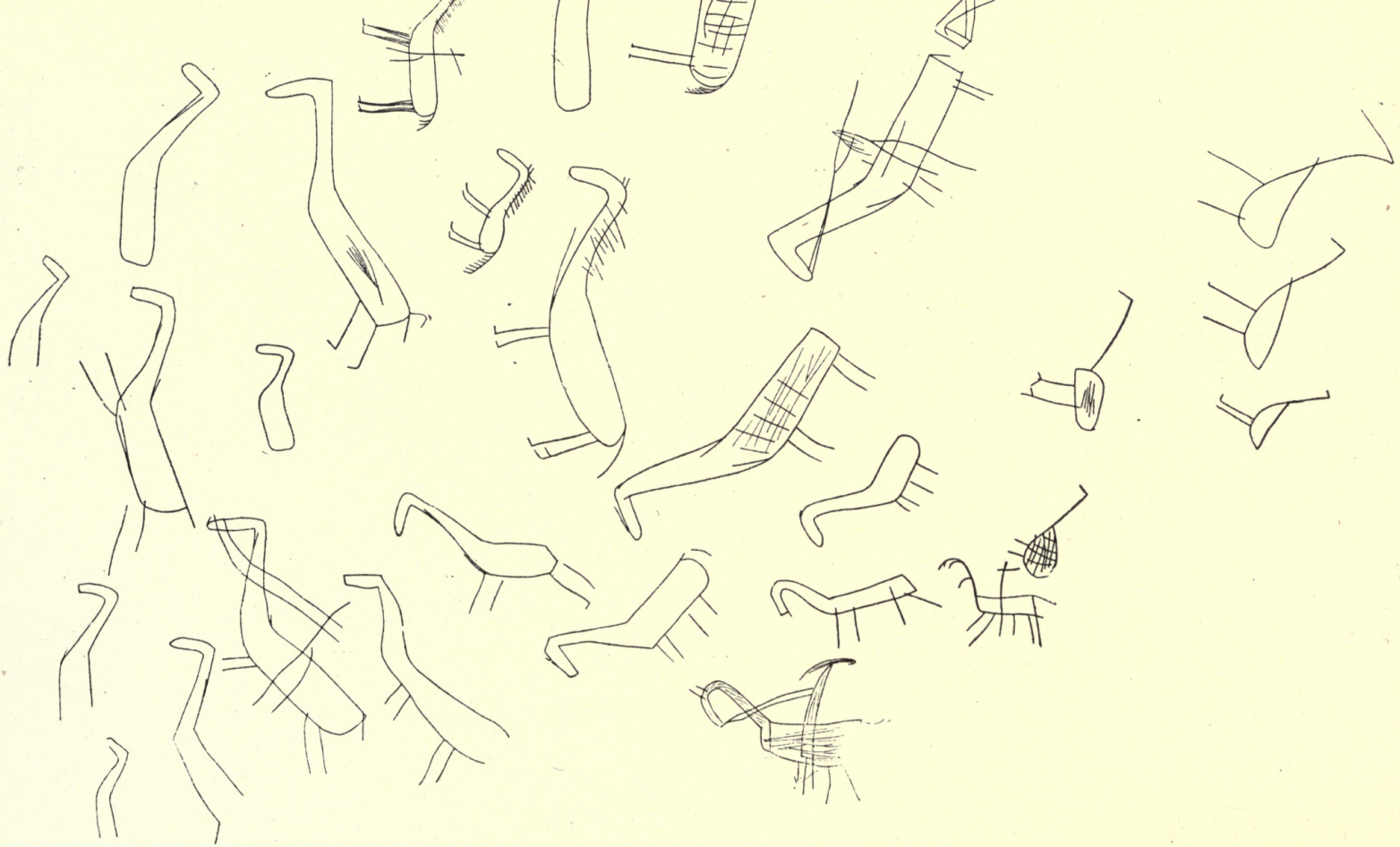


FIG. 31.—GROUP OF ENGRAVINGS ON ROCK, LOOGE KOPJE. (*Scale* $\frac{1}{5}$.)

The only scratching which I saw *in situ* was a shadowy representation of an elephant, which is one of the oldest petroglyphs there, having been almost effaced by the action of rain and wind, and weathered to the same black colour as the rest of the rock surface. Over it are engraved a blesbok, two springboks, and an eland, all of which are much lighter in colour and show up well against the dark background. Here is distinct evidence of considerable disparity in age, the figure of the elephant having already nearly become obliterated before the engravings were made. Apart from this one specimen it would be difficult to demonstrate any difference of age among the various petroglyphs there, though such may very well exist.

The finest series of small engravings in detail is that represented by Figure 29. It consists of a chain of animals (Gnu, Koodoo, Quagga, Eland, etc.) engraved along a narrow outcrop of rock. The quagga is specially interesting, as it is one of those formerly abundant mammals which have become totally extinct since the advent of the European.

I also noticed one example of the large engravings in outline. A tracing of it is reproduced in Figure 30. It depicts two superimposed elands facing in opposite directions.

On the flat at the foot of the randje, where the surface soil has been much subjected to wind erosion, I obtained a number of the characteristic lydian-stone flake-tools of the Solutric group as well as numerous very small chert, agate and jasper flakes, one or two of which had been trimmed into flake-tools.

Looge kopje lies to the south of Koffyfontein, and contains some engravings of a very interesting character. They are the work of Kafirs,* and depict the modern element, of which the figures of men on horses are typical, as opposed to the ancient element which is characterised by the aboriginal representations of the large locally extinct animals. They are all lighter in colour than the original rock surface. Figure 31 reproduces a tracing of a typical group of these petroglyphs. They should be compared with the Kafir paintings, figured further on, at Bestersvlei.

* There are a number of their characteristic circular walls of uncemented stones at Koffyfontein, of which the modern local Kafirs know nothing.

FIG. 32.—HUMAN FIGURES PECKED ON ROCK, BAVIAANSKRANZ. (*Scale* $\frac{1}{4}$.)

FIG. 33.—PAINTING REPRESENTING A FIGHT BETWEEN KAFIRS. (*Scale* $\frac{1}{6}$.)

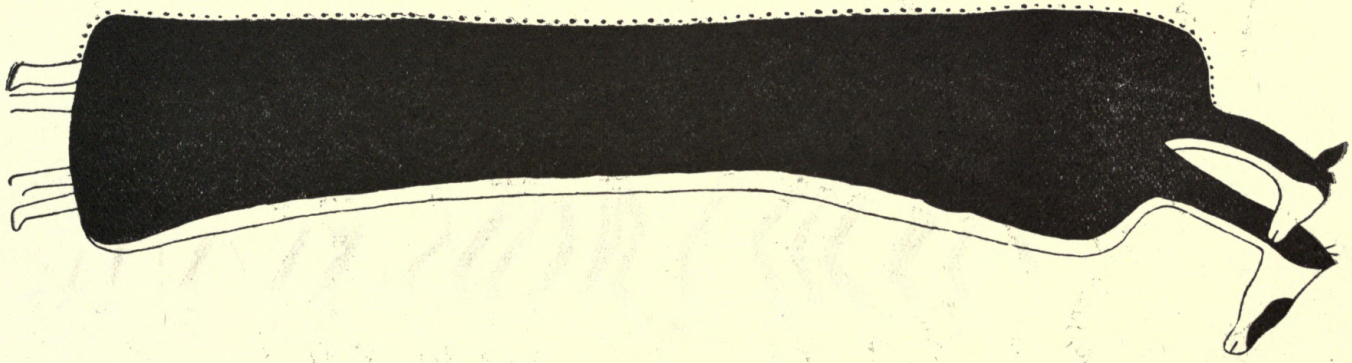
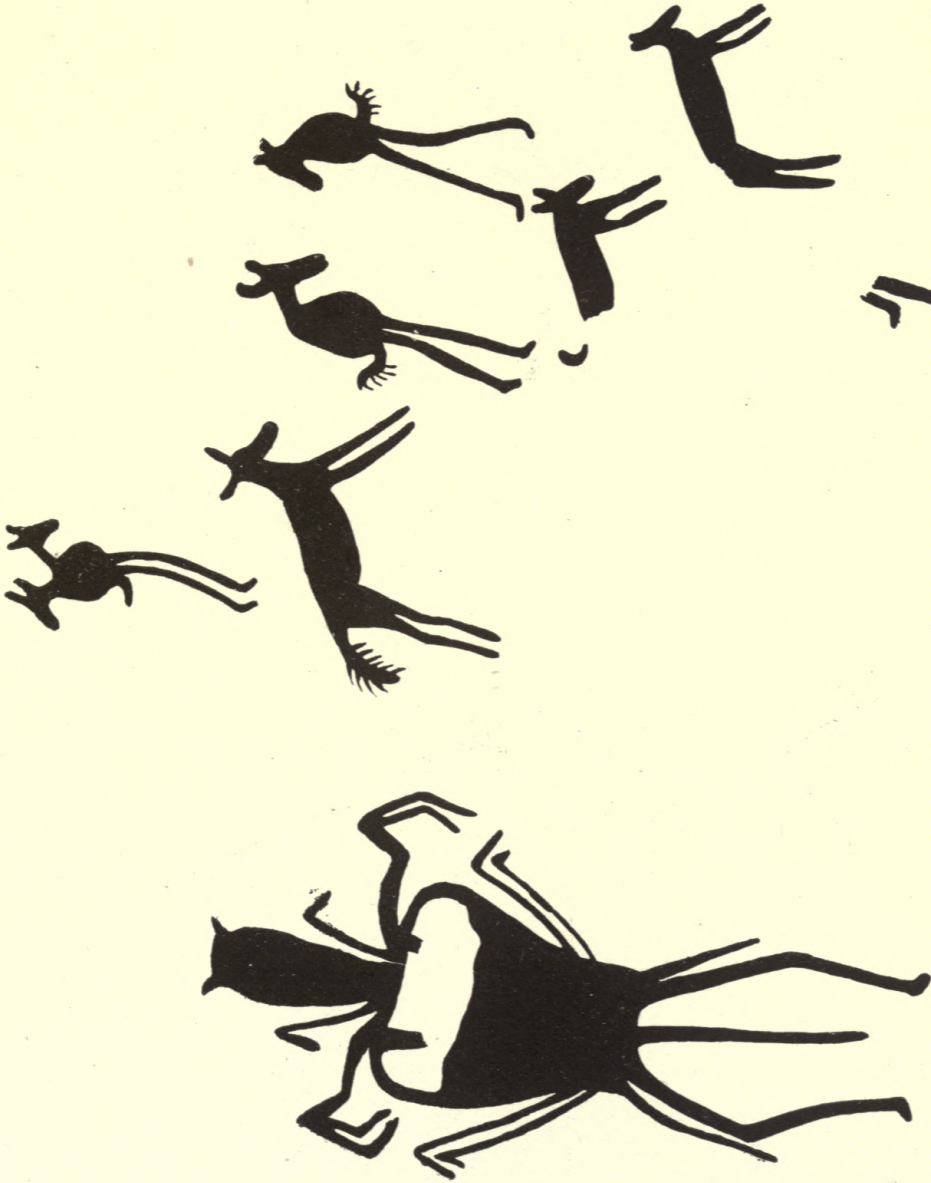


FIG. 34.—FIGURE OF A MYTHICAL BEING, PAINTED ON ROCK-SHELTER, MALOPASDRAAI (*Scale* ½).
The portion shown in outline is white in the original.



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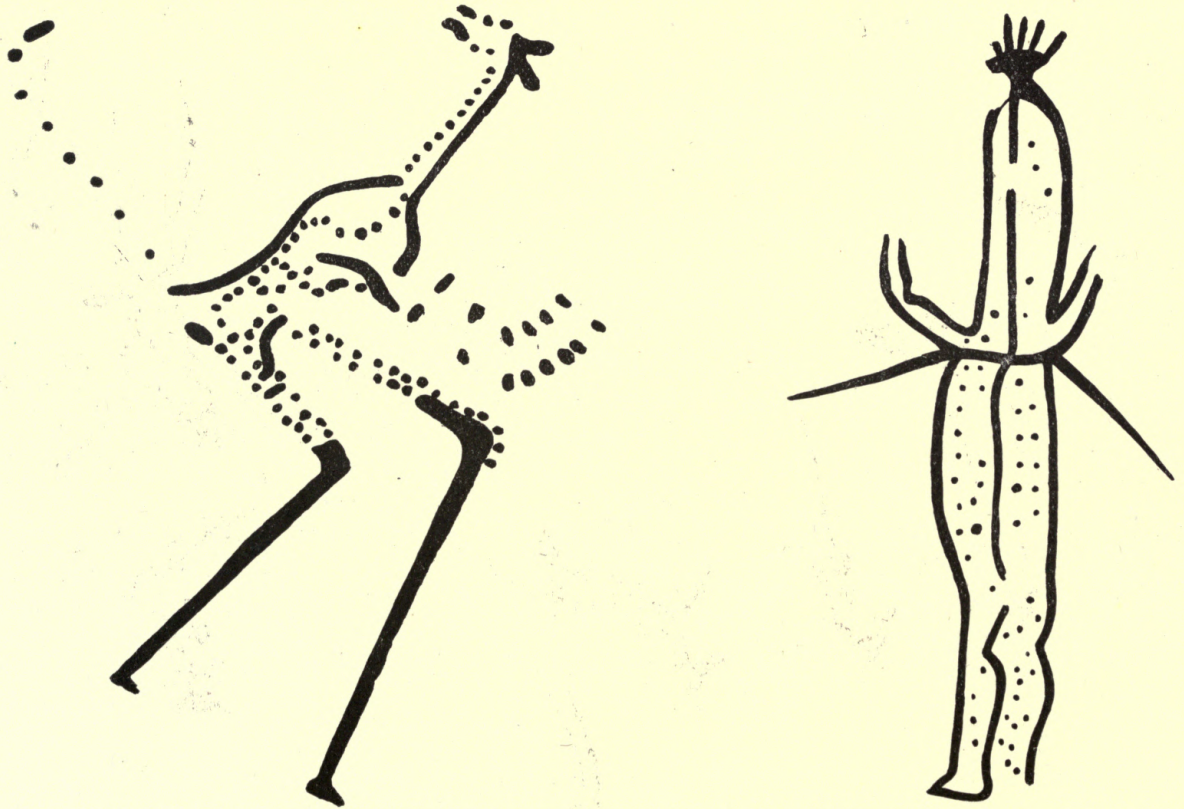


FIGS. 36 AND 37.—PAINTINGS OF HYÆNA AND MAN, BESTERSVLEI. (*Scale* ½ *and* ⅓).

The replacement of the life-like figures of the earlier engravings by stiff, conventional forms is noteworthy.

Along the eastern border of Orangia, where the cliffs of Cave Sandstone constitute a prominent feature of the scenery, and afforded numerous shelters to the aborigines, the engravings and peckings are replaced by paintings.

Several occurrences are known in the neighbourhood of the village of Fouriesburg, and I visited two of them.

The rock-shelter on the farm Malopasdraai has a large number,

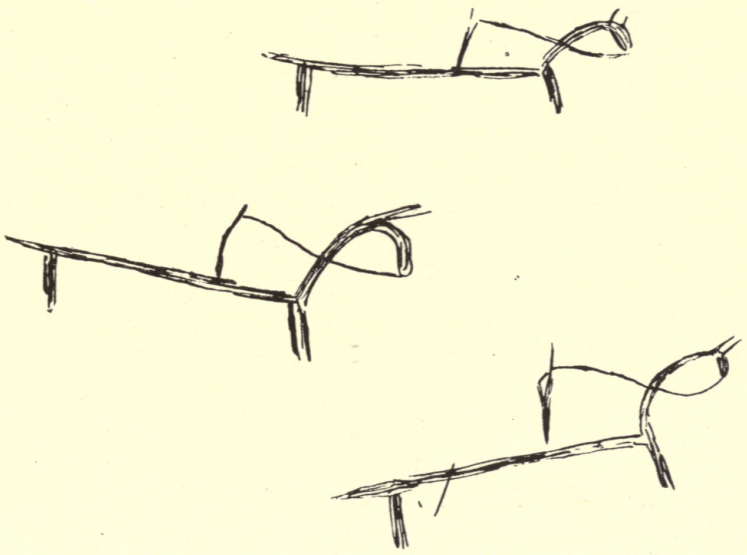


FIG. 38.—KAFIR PAINTINGS, BESTERSVLEI. (*Scale* ½.)

but they are mostly very indistinct. The most conspicuous painting is that of a fight between Kafirs, the greater part of which (Figure 33) was still sufficiently plain to admit of a tracing being made. This group is in red, as are the majority of the paintings, but the mythical being (Figure 34) from the same place is in red and white, as also are some representations of the eland.

In the rock-shelter on the farm Bestersvlei an even more interesting series occurs, but there also they are mostly very indistinct. Specially noteworthy is the group reproduced in Figure 35, which

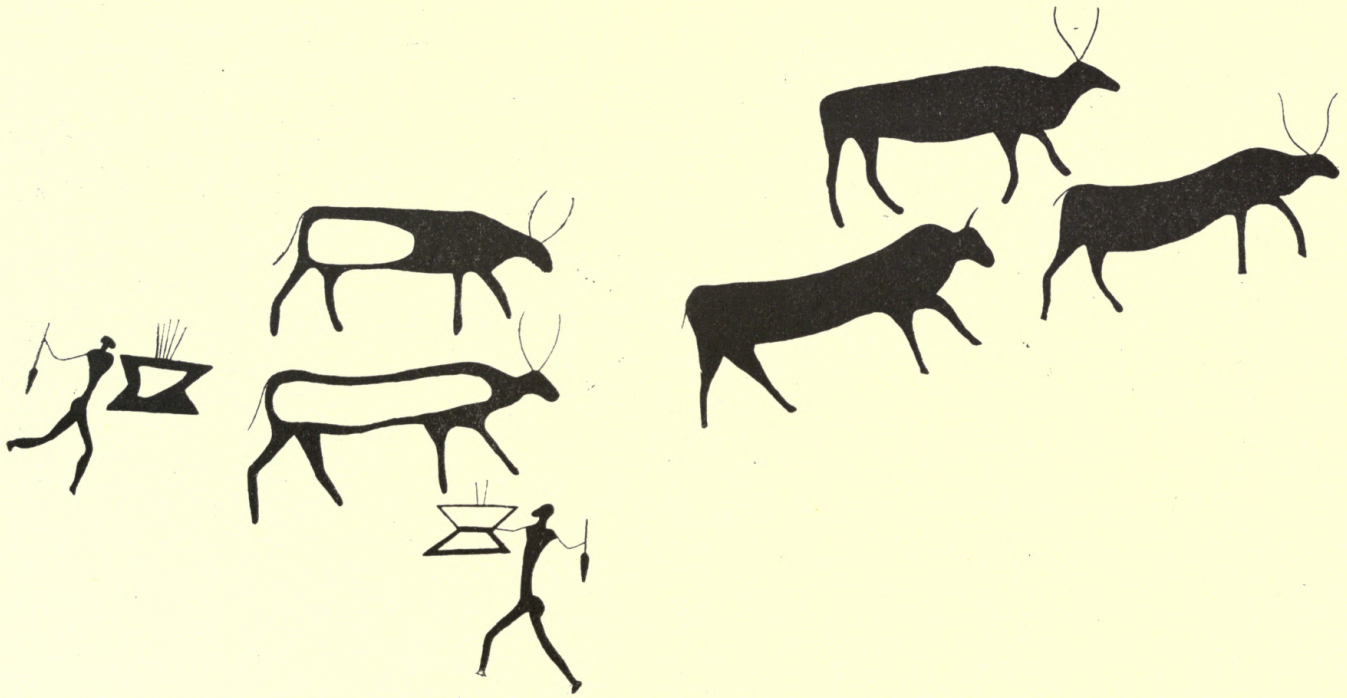


FIG. 39.—PAINTING REPRESENTING KAFIRS DRIVING OXEN, VRAAIUITZICHT. (*Scale* $\frac{1}{3}$).

evidently illustrates some myth. The representation (Figure 36) of what appears to be an hyæna is a peculiar specimen of aboriginal art; it is the only painting in polychrome there, the spotted portions having originally had a background of some pale tint which has disappeared, but has left a faint mark on the rock. Figure 37 is the only painting in outline that I have seen.

There are a number of Kafir paintings (Figure 38) and scratchings, showing men on horses, there also, which are interesting to compare with the engravings, already referred to, at Looge kopje.

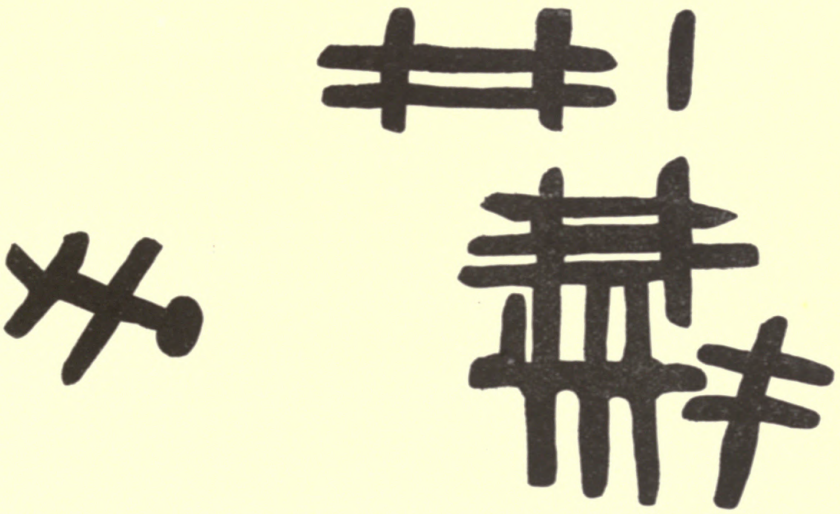


FIG. 40.—GEOMETRIC FIGURES PAINTED ON ROCK-SHELTER, JULIJSKRAAL (*Scale* ½.)

I obtained some characteristic minute Solutric flake-tools in this shelter.

At the farm Vraaiuitzicht, about two hours' drive from the village of Ficksburg, there are two very interesting groups of paintings. The one, reproduced herewith (Figure 39), is different to any that I have seen before, in that the outline had been lightly engraved prior to the application of the pigment; it is also in black instead of the commoner red. The other is a group of elands, depicted in black and white, and exhibiting, as many of the polychrome figures

do, distinct, though incipient, shading. I found a number of minute flake-tools of Solutric type under this shelter.

On the farm Julijskraal, about three-quarters of an hour's drive from the same village, there is a fine series of paintings all in red. Among them is a group of geometric figures (Figure 40)—the first I have seen among paintings; a Kafir explained them to me as being records of journeys, the vertical lines representing men, and the horizontal lines the rivers crossed by them.

I was shown near there a cliff which had been formed 27 years ago by the breaking away of a mass of sandstone, and which looked as new as if it had only been formed yesterday; the faces on which the aboriginal paintings occur are not nearly so fresh in appearance.

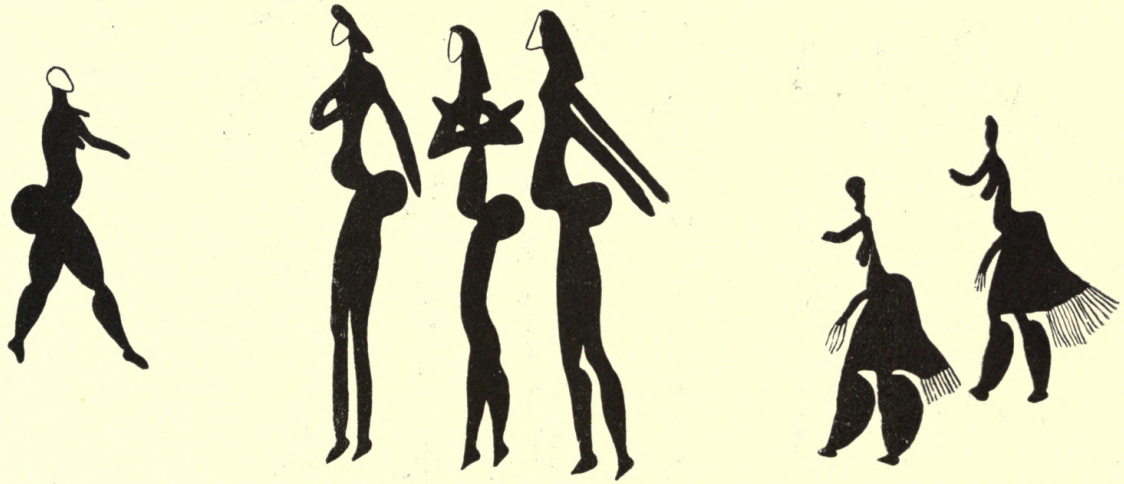
There are some paintings in red at the base of the overhanging cliffs which cap the elongated tafel-kop at the back of Ficksburg, but they are now very indistinct. In a kloof towards its south-western end there is, I was told, an eland depicted in polychrome. On a detached mass of sandstone, surrounded by a clump of trees, at its north-eastern end, there are numerous paintings in red, but only two or three, includings pictures of an elephant, which seems to have been a favourite of the aborigines, and of an aard-vark, are distinct. Close by these last I found a number of minute chert flakes and flake-tools of Solutric type.

At Modderpoort, in the cliffs at the back of the Mission Station, there are three rock-shelters which I examined under the guidance of the Rev. W. A. Norton. They contain a number of aboriginal paintings. One fresco is specially interesting because it shows work of three different ages. I obtained a large number of minute chert and agate flake-tools of Solutric type in these shelters, as well as a bone pin (portion of arrow) like those from Devilliersrust.

On the south side of the kopjes on the farm Omega, there are rock-shelters with paintings, while on the north side is a cave on the front of which are more paintings. Both series are now, unfortunately, very indistinct. I obtained some small chert and agate flakes, as well as one or two minute flake-tools of the Solutric group from both the shelters and the cave.

The village of Ladybrand is almost completely encircled by cliffs in which rock-shelters occur at intervals. I examined some

FIG. 41.—PAINTING OF PROCESSION OF KAFIR WOMEN, JULIJSKRAAL. (*Scale* 1/1.)



FIGS. 42, 43 AND 44.—FIGURES OF KORANNA AND KAFIR WOMEN, MODDERPOORT, LADYBRAND, AND FICKSBURG. (*Scale* $\frac{1}{3}$). The parts shown in outline are painted white.

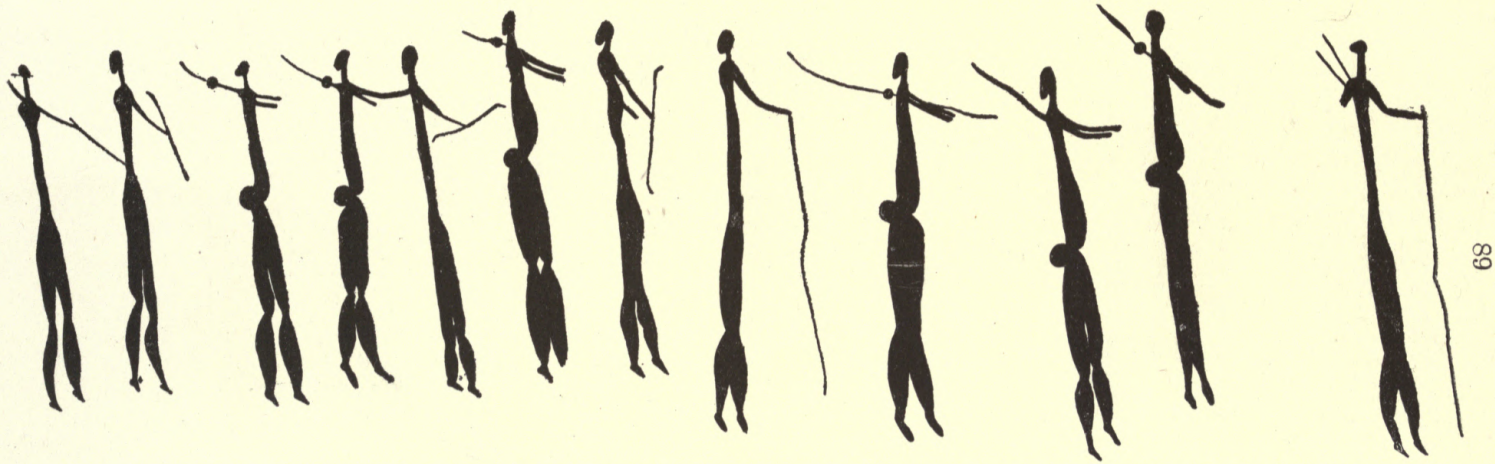


Fig. 45.—PAINTING OF A PROCESSION OF KORANNAS OR BOSJESMAN, SHOWING PERFORATED STONE BALLS ON STICKS, LADYBRAND. (*Scale* ½.)

of these under the guidance of Mr. Caplin. Most of them contain aboriginal paintings, and all yield small chert and agate flakes, while here and there a minute flake-tool of Solutric type is to be found in them.

All the shelters have been subsequently occupied by Kafirs, who have built in front of them characteristic low semi-circular walls of uncemented stones, and close by, circular cattle pens of similar construction. Portions of clay dolls, fragments of pottery with a red gloss, glass beads, and crude paintings made in emulation of their artistic predecessors, also bear witness to the nationality of these later occupants, while in some cases the remains of their mud-walled huts are still preserved.

Most of the aboriginal paintings are now indistinct, having suffered severely from the attacks of the atmosphere; many have become mutilated and scrawled over by both Kafir and European; while others have become completely obliterated by the smoke of fires. One large shelter due west of the village is a painful sight on account of the extent to which it has suffered at the hands of these vandals. Judging from the shadowy forms still traceable here and there, it must once have been covered with representations of hunting scenes and dances. One only of the numerous interesting paintings (Figure 45), which once adorned this shelter has, mainly on account of its being out of reach of the casual visitor, almost retained its original brightness.

The paintings are mostly in one colour, sometimes black, but more often red. Some of the animals, especially the eland, which seems to have been a favourite subject, however, are in two or more colours. While the human figures are as a rule grotesque, those of animals usually show real artistic merit.

CHAPTER IX.

FARMING PROSPECTS.

FARMING is the mainstay of Orangia, which is fortunate in possessing a population fond of the land and content with the isolated existence entailed. It could, however, in spite of its many natural disadvantages, be made to support an immensely larger community. The great bar to the full utilisation of its potentialities is, as in other parts of the world, the private ownership of the land. It belongs to a comparatively small number of people, who are satisfied with a bare living and, being free from competition, make no effort to introduce those artificial improvements without which the ground cannot be made to yield its maximum. The increase of the present population may in time remedy this, but experience of older communities suggests that it is more likely to result in what is undoubtedly the greatest of national curses, namely, the migration of the young men to the towns.

As I have already remarked, the extreme west is one of the most dreary and barren regions imaginable, short of absolute desert, while the eastern border is as fair and fertile a region as could be wished. The greater part of Orangia may be described as semi-arid. One would not, perhaps, be justified in using this term if it were based on the amount of rainfall alone. A ten years' record of the rainfall at Kimberley, Kroonstad, and Bloemfontein, gives for the six so-called winter months, 4.6, 5.5, and 6.6 inches, and for the six summer months, 15.8, 21.6, and 18.8 respectively. These figures compare favourably with those of other well-known semi-

arid regions. But the rainfall is so very torrential and intermittent that, without means of conservation, it is largely wasted. The rain may all fall towards the beginning and end of the season, with a long interval of drought in between. Except along the few rivers, the flatness of the country prevents the conservation of this water in dams, owing, as has been demonstrated in discussing the pans, to the large proportion necessarily exposed to the sun and the high rate of evaporation.

The country is not, as a whole, suitable for agriculture. Its possibilities lie more in stock-raising. But the latter is to a great extent dependent on the former. The best results can only be obtained by a combination of the two.

Sheep and goats thrive well in Orangia, and constitute the staple industry, but it is manifest that the natural food supply of this parched country sets a limit to their numbers that could be raised very considerably by artificial means. The need is greatest towards the end of the dry season, that is, during the three months from July to September inclusive, when the veld has been denuded of its vegetable covering by beast and drought. It has been shown that certain grasses and plants can be successfully grown on dry lands for winter feed for small stock. The raising of crops that can be used in part to supplement the grass and schaap-bosjes as food for the animals, is highly desirable. But to do this water must be conserved.

Ordinary methods of conserving the rain water, as already remarked, are out of the question, and that obtained from the wells is insufficient for irrigation purposes.

There is, however, another method that has met with great success in other and less favoured countries, and that is the conservation of moisture in the soil by means of deep ploughing.

The recent introduction of this method by McLaren, near Vereeniging, has been markedly successful, and has revealed potentialities hitherto undreamt of. In this cases the crop grown is mealie (maize)—the stalks of which afford a valuable bye-product when utilised as fodder—but certain varieties of oats, rye, barley, and wheat could be raised in the same way. Kafir-corn is one of the best of the drought-resisting cereals that also yield a winter

fodder, and is susceptible to considerable improvement on dry lands by scientific application of the principles of deep ploughing.

The average farmer grows mealies only, and merely enough for his own requirements. They thrive well, even on the sand-covered bults of the western belt, in spite of his primitive methods, but are completely at the mercy of a drought.

Deep ploughing requires the use of steam ploughs and accessory tackle which necessitates co-operation between a number of farmers.

McLaren estimates that the amount of land that his steam plough can turn over is 15 to 20 acres of ordinary veld per day. The consumption of coal he gives as at three tons of Vereeniging "seconds" (7/6 per ton) per day. The percentage cost of breakages is small. Three white men are usually employed upon each steam tackle, which consists of two engines, one five-furrow plough, cultivator, consolidator, and a set of six harrows, water cart, and sleeping van, costing £4,500 approximately, delivered f.o.r. The white men could probably be hired at £12 per month, and the overseer at £15; five Kafirs at £2 10s. per month are also required. A syndicate of farmers purchasing one of these could plough practically all the year round, and reckon on doing 2,500 acres. Mealies can be produced on new lands at 5/3 per bag; on old lands the cost is still lower. The yield per acre is about 8 bags.

The fertile eastern border is better suited to cattle and horses than sheep and goats, and is favourable to the growth of wheat, which is largely raised in place of the less valuable mealie.

Sheep, goats, and cattle are periodically subject to many of the diseases prevalent in South Africa, though not to so great an extent as in the country further north. Occasional hailstorms cause serious damage. Of recent years wheat has been subject to the depredations of the common aphis which has completely destroyed the crops over large areas.

The greatest plague, and a very serious one, is the locust. I shall never forget the insight into its depredations which I obtained during my residence of little more than a year near Boshof. The surrounding country is typical of western Orangia. It is a monotonous waste dotted with innumerable pans, which alternate with

clay flats and sand-covered bults. One may travel through it for hours without seeing a bush. All the year round it is swept by ceaseless discomforting winds which, in the cool months, June, July and August, chill one to the bone, and in the warm weather scorch one's cheeks like tongues of flame. It is a veritable wilderness. The monotony of the landscape is accentuated by its generally dried up appearance. With the advent of the rains, the veld takes on a coat of green, but the voracious voetgangers come at the same time, and their winged descendants remain till the rains are over, and the last blade of green grass has gone. Yet the Boer, with his huge farm, is able to keep large flocks of sheep and goats, and a few oxen.

The voetgangers, it should be explained, are the young locusts which are still in the hopping stage. They march across the green veld in huge brown armies, eating everything in their track. They have a habit of collecting together in heaps during the night for warmth, and can be surprised thus and destroyed in the early morning. When they reach the flying stage they are more difficult to deal with. The first intimation of their approach then is a smoke-like cloud on the horizon. A few hours later the air is full of them. In such great quantities do they sometimes come that they obscure the sun's rays, and produce a gloom that is not equalled on the cloudiest day.

During the visit of the locusts both bird and beast grow fat. Kafirs eat them and stock thrive on them. But this does not compensate for the havoc wrought. The brief feast is followed by a long fast.

Insect life is the root of the majority of the farmer's troubles in Orangia as in other parts of the subcontinent. It is the cause of some and the propagator of most of the animal ills, and is the active agent in the destruction of the crops. It is not difficult to see why South Africa, in spite of its fine weather and fertile soil, is so inferior to Canada, from the farmer's point of view. There climatic conditions are inimical to insect life, which withers away before its icy winters, here everything is in favour of the insect order. South Africa, indeed, is the paradise of the Hexapoda.

CHAPTER X.

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(Names of farms in Italics.)

Printed by EDWIN SEARS & Co., 4, Dorset Buildings, Salisbury Square, London, E.C.